

#### Defense Special Weapons Agency Alexandria, VA 22310-3398



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### **Underground Technology Program Test Adit Construction**

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November 1996

**Technical Report** 

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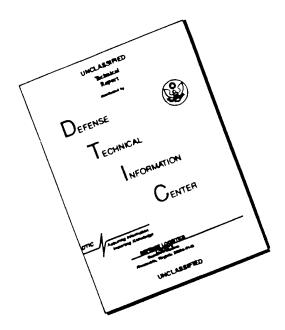
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#### SUMMARY

This report describes the geotechnical investigation, design, and construction of a test adit which was built to support the Defense Nuclear Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.

The geotechnical investigation includes preconstruction geologic exploration, geologic mapping, gas detection, and soil and rock hydrology. The information provided is also the result of onsite inspection, quality control review, and instrumentation of ground support areas, all performed during the course of construction.

The contractor's methods of construction are also examined, as are the remedial methods taken when methane gas was encountered during the course of construction.

#### PREFACE

This report documents work performed as part of the DNA Underground Technology Program, and was funded under contract DNA001-92-C-0051. The DNA Project Managers were Major Curt Krieser and Paul Senseny. The Army Corps of Engineers, Louisville District, inspectors were Mr. Tony Hamblin and Mr. Steve Duncan. The Waterways Experiment Station (WES) Site Manager was Mr. David Ward.

For Lachel and Associates: Mr. James E. Beck was in charge of overall project management; Mr. Lawrence Eckert and Mr. Ghailan Alsayab provided the geologic and tunnel engine-ring field work; Mr. Dennis Lachel and Mr. Rich Linamen provided the off-site tunnel engineering support; and Mr. Gunnar J. Radel reviewed and edited the final report.

Detailed information on the preconstruction geologic explorations and investigations can be found in Volumes 2 and 3 of the "Solicitation for Underground Technology Program, Test Adit Construction, 1992" which contains the Geotechnical Design Summary Report prepared by Lachel and Associates.

#### CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY	BY	→ TO GET
TO GET ←	BY ←	- DIVIDE

angstrom	1.000 000 X E -10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn .	1.000 000 X E -28	meter <sup>2</sup> (m <sup>2</sup> )
British thermal unit (thermochemical)	1.054 350 X E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm <sup>2</sup> )	4.184 000 X E -2	mega joule/m <sup>2</sup> (MJ/m <sup>2</sup> )
curie	3.700 000 X E +1	≋giga becquerel (GBq)
degree (angle)	1.745 329 X E -2	radian (rad)
degree Fahrenheit	$t_{\mu} = (t^{\circ}f + 459.57)/1.8$	degree kelvin (K)
electron volt	1.au2 19 X E -19	Joule (J)
erg	1.000°000 X E -7	joule (J)
erg/secard	1.000 000 X E -7	watt (H)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	meter <sup>3</sup> (m <sup>3</sup> )
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)'
kip/inch <sup>2</sup> (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktap	1.000 000 X E +2	newton-second/m <sup>2</sup> (N-s/m <sup>2</sup> )
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (7bs avoirdupois)	4.448 222	nevton (N)
pound-force inch	1.129 848 X E -1	newton-meter (N°m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/foot <sup>2</sup>	4.788 026 X E -2	kilo pascal (kPa)
pound-force/inch <sup>2</sup> (psi)	6.894 757	kilo pascal (kPa)
pound-mass (1bm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-foot <sup>2</sup> (moment of inertia)	4.214 011 X E -2	kilogram-meter <sup>2</sup> (kg'm <sup>2</sup> )
pound-mass/foot <sup>3</sup>	1.601 846 X E +1	kilogram/meter <sup>3</sup> (kg/m <sup>3</sup> )
rad (radiation dose absorbed)	1.000 000 X E -2	≕Gray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -B	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (sm Hg, 0°C)	1.333 22 X E -1	kilo pascal (kPa)
	1	1

<sup>&</sup>quot;The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s. "The Gray (GY) is the SI unit of absorbed radiation.

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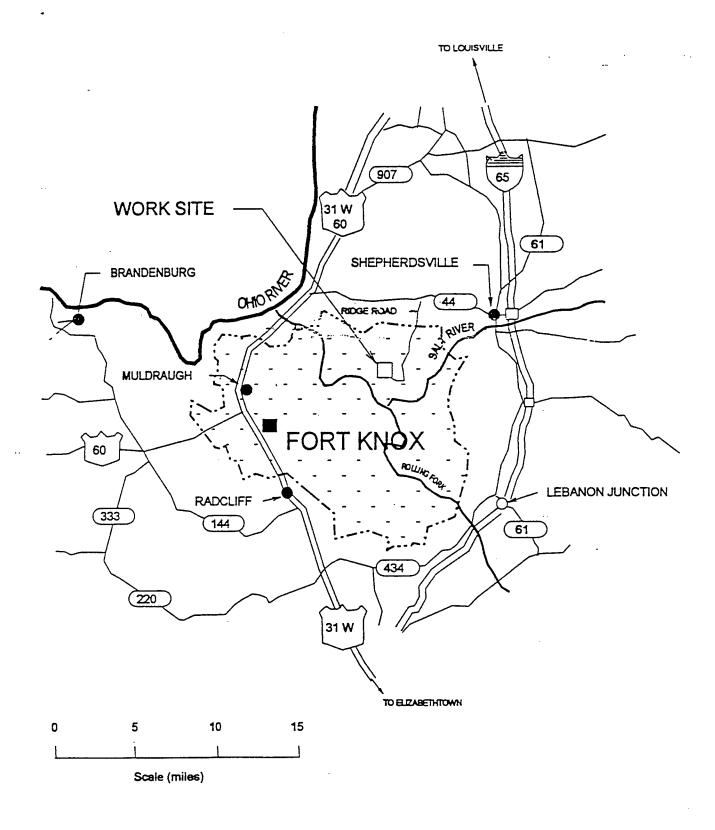


Figure 1-1. Location Map.

#### SECTION 1

#### INTRODUCTION

#### 1.1 UNDERGROUND TECHNOLOGY PROGRAM.

The Underground Technology Program (UTP) is a part of the Government's continuing research to evaluate the lethality effects of dynamic loads on underground structures, and to develop a high-confidence method for predicting these effects. This method is being developed through both theoretical and analytical activities, combined with field tests and experimental activities. This research is sponsored by the Defense Nuclear Agency (DNA).

#### 1.2 TEST ADIT CONSTRUCTION.

As part of the overall Underground Technology Program, DNA is developing an underground high explosive test bed at the Rodgers Hollow Area, Fort Knox, Kentucky, to support field tests and experimental activities. The test adit construction contract is the first phase in developing the test bed. Rodgers Hollow is located on the Fort Knox Military Reservation approximately 7.4 miles west-southwest of Shepherdsville, Kentucky, in Bullitt County. The Rodgers Hollow geographic coordinates are 37° 56′ 57.40308" North and 85° 50′ 34.56814" West at an elevation approximately 490 feet above mean sea level (MSL). The site location plan is shown in Figure 1-1.

The test adit was constructed by W. L. Hailey and Company, Inc. of Nashville, Tennessee under U.S. Army Corps of Engineers contract DACA27-92-R-0003 administered by the U.S. Army Corps of Engineers, Louisville District. LACHEL and Associates, Inc. of Golden, Colorado performed the tunnel design, prepared the contract drawings and specifications, and provided onsite geotechnical assistance during the construction period. The U.S. Army Corps of Engineers Waterways Experimental Station (WES) provided overall program management for the UTP and site management of the Rodgers Hollow test site.

#### 1.3 REPORT ORGANIZATION.

This report is divided into six sections and appendices. This introduction (Section 1) is followed by a description of the test adit construction project (Section 2) and changes to the original adit design. Section 3 describes the geology and hydrology of the Rodgers Hollow site. Section 4 describes construction methods and

production rates. Section 5 describes the tunnel instrumentation, and Section 6 is a list of references. The Appendices A through D contain the geologic core logs, rock test results, geologic maps, and photographs, respectively.

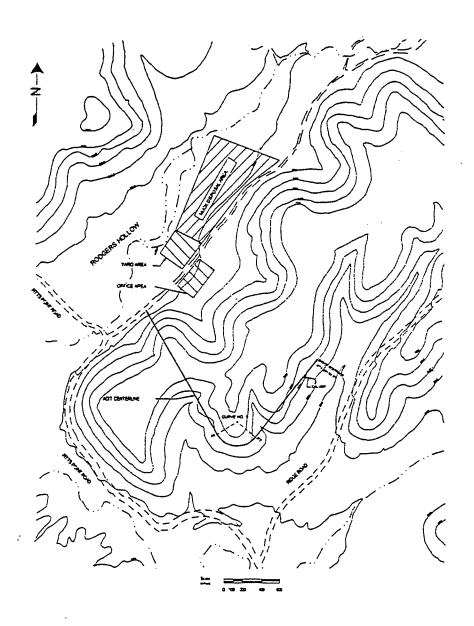


Figure 2-1. Project Site Plan.

#### SECTION 2

#### PROJECT DESCRIPTION

#### 2.1 GENERAL.

The UTP Test Adit Construction contract was designed to provide access to the test bed located in the Louisville Formation, approximately 300 feet below the floor of Rodgers Hollow. The major items of work required by the contract included surface site work, one flood protection structure, 36 feet of cut-and-cover portal structure, 3,035 feet of 12 foot by 12 foot adit, 100 feet of 8 foot by 8 foot adit, four enlargements in tunnel cross section, and electrical, ventilation and dewatering systems.

A Request for Proposals (RFP) was issued in May, 1992, which required the submission of a two-part proposal, Technical and Cost, in separate envelopes. The cost proposal was a firm fixed price based on contractor developed unit prices for a schedule of bid items included in the RFP. The proposals were evaluated first on technical merit, and then on cost. A total of ten proposals were received in June, 1992, ranging in value from a low of \$3.8 million to a high of \$8.0 million. After evaluating the Technical Proposals, establishing a competitive range, and determining the most advantageous proposal to the Government, a contract was awarded to W. L. Hailey & Co., Inc. in July 1992, for an approximate value of \$4,665,000.

#### 2.2 AS-BID PROJECT CONFIGURATION.

#### 2.2.1 Site Work.

As part of the test adit construction, the contractor was required to provide and upgrade surface site facilities. Included in this item are the upgrading of the gravel road in Rodgers Hollow, providing office trailers, parking areas, contractor's laydown areas, clearing and grubbing for the portal, muck disposal, the installation of sediment control tanks, and 6,800 feet of surface discharge water line. Figure 2-1 shows the original site layout. Also included in this item of work was the providing of normal site services and maintenance such as furnishing potable water, sewage disposal, trash removal, guard service, the cleaning of offices and yard areas, and the supply and distribution of electrical power on surface.

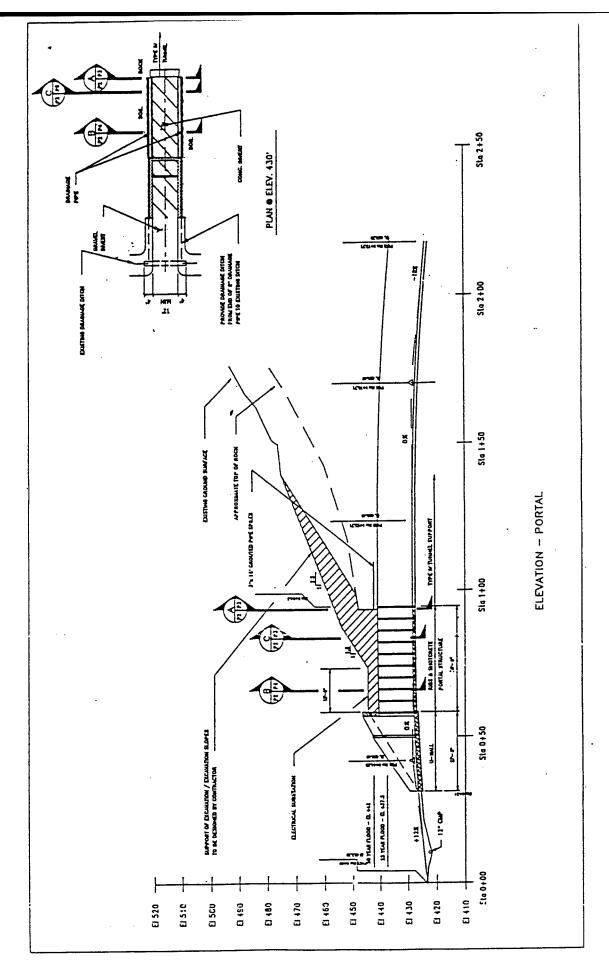


Figure 2-2. Portal Construction.

#### 2.2.2 Portal Structures .

The portal to the test adit is comprised of two sections, a flood protection structure, and a cut-and-cover tunnel section, as shown in Figure 2-2 opposite. The flood protection structure, from Station 0+31 to Station 0+58, is a U-shaped reinforced concrete structure with removable timber stop logs (shown on Figure 2-3 on the next page). During normal operation of the site, the stop logs are removed and the structure provides unimpeded access to the portal. During flood events of the Salt River basin, the stop logs are installed in the cast-in-place guides, and an temporary earth dike is constructed in front of the stop logs to provide flood protection for the tunnel adit for a 50 year flood. When the stop logs are in place, access to the tunnel for both men and tunnel utilities is provided via the open area between the stop logs and the concrete portal at Station 0+58.

The cut-and-cover portal structure, from Station 0+58 to Station 0+94, consists of a 6 inch thick wire reinforced shotcrete with horseshoe shaped, steel arch sections (W6x25s) 4 feet on center and a 1 foot thick reinforced concrete slab at the tunnel invert. The outside of the structure is coated with an asphaltic dampproofing. A 6 inch perforated drain pipe is provided at the base of the wall on either side to prevent surface water from entering the tunnel. Figure 2-4, which follows, provides details of the structure. The portal was constructed in an open cut in the side of the hill and backfilled with structural material prior to commencing tunneling operations.

#### 2.2.3. MAIN ADIT.

The main adit consists of 2,935 feet of 12 foot wide by 13 foot high, straight legged, horseshoe-shaped tunnel which commences at Station 0+94 and progresses downgrade on a 10 per cent slope to Station 30+29. It penetrates completely through the New Providence and New Albany Shales and terminates in the middle of the Louisville Formation, 286 feet below the portal elevation and approximately 458 feet below the top of the hill (see Figure 2-5 on page 9). The main adit alignment consists of two tangent sections, at bearings S31°06'53"E and N39°18'46"E, and a 250 foot radius curve.

A total of four widened areas or bays were required to be excavated within the main adit. The tunnel width increased to 17 feet in the bay areas to accommodate permanent electrical and mechanical equipment. Two of these bays were for electrical transformers and circuit panels, which are located at Station 15+00 and Station 29+73, and offset to the right of tunnel centerline. The other two bays contain dewatering sump boxes and pumps and are located at Station 14+56 and Station 30+17, and are offset to the left of the

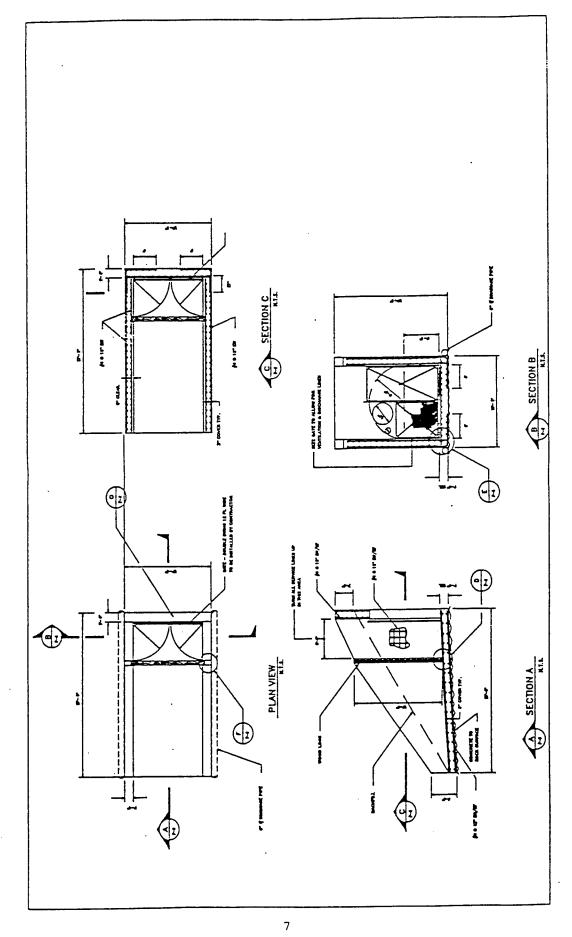


Figure 2-3. Portal U-Wall.

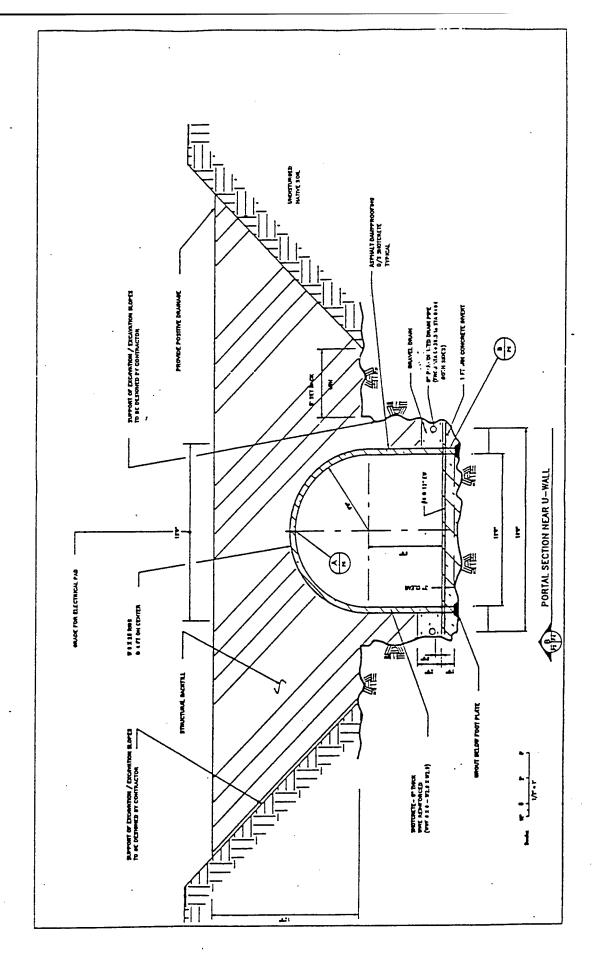


Figure 2-4. Portal Section.

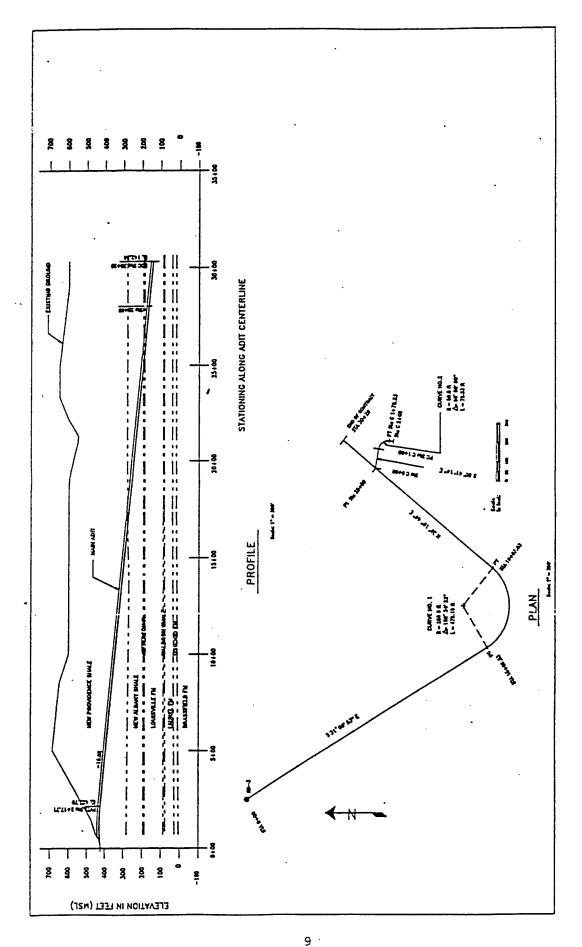


Figure 2-5. As-Bid Plan & Profile.

tunnel centerline. The design configuration of the main adit included a 12 inch thick gravel invert and a permanent lining of 2 inches of shotcrete in the shale formations, and chain link fabric in the top 120° of the crown in the limestone formations.

#### 2.2.4 Calibration Adit and Drift.

The calibration adit forms a Y-intersection with the main adit at Station 28+00 and progresses on a S80°41′14″E bearing away from the main adit. This adit is a 12 foot wide by 13 foot high tunnel similar in cross section and configuration to the main adit and extends from Station C 0+00 to C 1+00. At Station C 1+00, the cross section reduces to an 8 foot wide by 8 foot high drift which continues to the termination of the drift at Station C 2+00. The drift is not lined with shotcrete or chain link fabric, nor does it have a gravel invert.

#### 2.2.5 Ground Support.

The design of the permanent tunnel support was based on data obtained through the geotechnical explorations conducted at the site as detailed in Section II of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) included in Vol. 2 of the "Solicitation for the Underground Technology Program Test Adit Construction", and summarized in Section 3 of this report. The primary basis for the design of tunnel support was the Norwegian Geotechnical Institute (NGI) Q-system which is a quantitative design method based on the evaluation of hundreds of tunnels. The method considers a variety of parameters that are known to affect tunnel stability.

The initial ground support calculations, based on the data obtained during the geotechnical investigation, indicated that the formations to be excavated (the New Providence Shale, the New Albany Shale, and the Louisville Carbonate) required only minimal support, for example, spot bolting in localized areas. However, it is recognized that even the best geotechnical investigation can only identify those features which are intersected by the borings, and that subsurface conditions between borings may vary considerably. Therefore, it was decided to provide four tunnel support designs in the contract to accommodate the likely variations in ground conditions which might be encountered during construction. As the tunnel was excavated, the actual ground conditions encountered were evaluated by a geotechnical engineer familiar with the design requirements, and the most appropriate tunnel support design was selected for each region. This approach allows the contractor the greatest flexibility in constructing the tunnel while affording the owner the lowest cost alternative based on the actual conditions encountered.

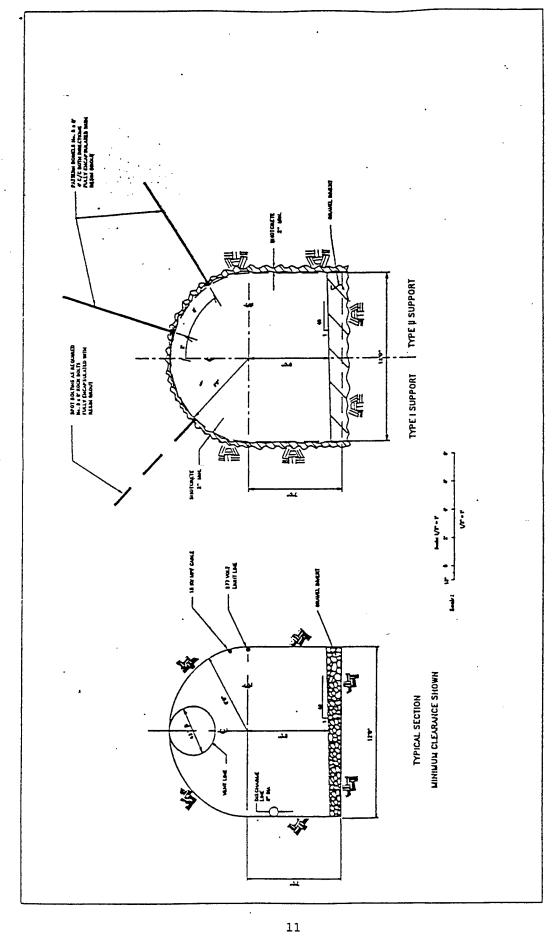


Figure 2-6. Tunnel Supports.

In determining the permanent ground support requirements, the rock geotechnical characteristics developed during the investigation were the primary factors considered in the design. However, additional factors such as extent of weathering, proximity to the surface, material durability, and dynamic loading from the future test events were also considered in determining the final Based on the evaluation of rock mass support requirements. characteristics and future use of the site, four types of tunnel support were selected for use in the contract. The support methods included: Type I Support, spot rock bolts (Number 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type II Support, pattern rock dowels (No. 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type III Support, pattern rock dowels (No. 8 by 8 foot long at 4 foot on center) with chain link fabric in the top 120° of crown; and Type IV Support, W6x25 steel sets at 4 foot center-to-center spacing. While the exact locations for each type of support were not determined at the time of bid, the contract provided an estimate of the quantity of each type for bidding purposes. These ground support methods are depicted in Figure 2-6, (Type I and II) and Figure 2-7 on the following page, (Type III and IV).

In addition to the main adit support designs detailed above, permanent ground support designs for the two transformer bays, two sump bays and the Calibration Adit intersection were specified in the contract. This consisted of pattern rock bolts (No. 8 by 10-foot long 4 foot on center) and a 2 inch thickness of non-reinforced shotcrete for the four bays, and a 4 inch thickness of wire reinforced shotcrete for the Calibration Adit intersection.

In the shale formations, the anticipated primary failure mode was the deterioration of the rock surface due to moisture loss, commonly referred to as air slaking, which causes the rock to ravel (disintegrate into pieces). To prevent this deterioration, a 2 inch minimum thickness of shotcrete was specified throughout the shale formations, and it was necessary to seal the shale with shotcrete within 24 hours of exposure to the atmosphere. In order to facilitate the tunnel advance and reduce the cost of the project, the specifications allowed the shale to be covered with a air-excluding sealant within the first 24 hours of exposure to temporarily protect the rock surface from deterioration or air slaking. The permanent shotcrete lining was then applied some distance behind the advancing face, effectively removing it from the daily mining cycle and allowing the contractor to utilize a separate and more efficient operation.

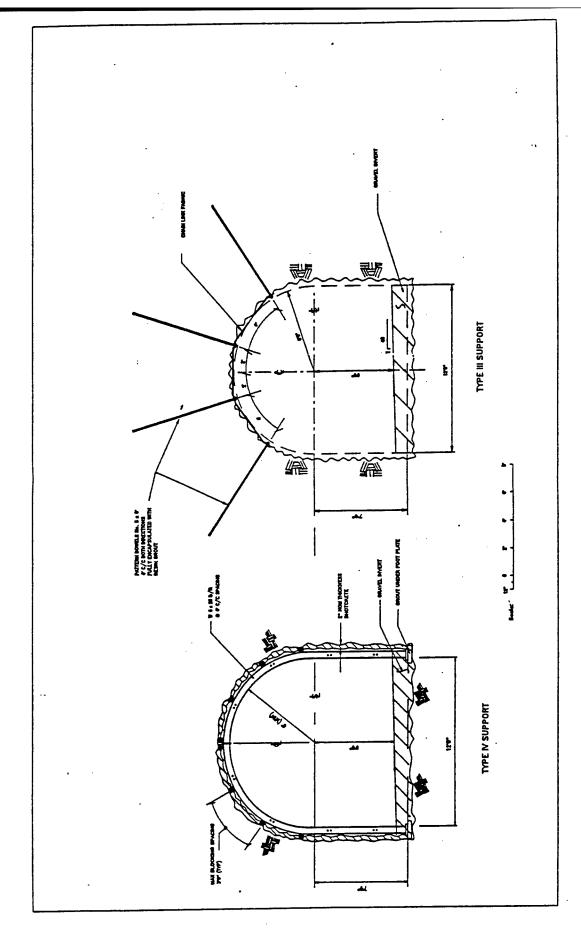


Figure 2-7. Tunnel Supports.

#### 2.2.6. Electrical and Mechanical Systems.

The contract included a permanent electrical power distribution and lighting system for both the surface and underground work areas. This system included the 1,000 kVA main substation located above the adit portal. The system also included transformers and distribution systems for the contractor's yard area and the tunnel services. The tunnel system consisted of three substations each comprised of a transformer and power distribution panels. One substation was located together with the main substation on surface, and the other two substations were installed in enlargements in the main adit at Station 15+00 and Station 29+73.

The permanent mechanical systems included a tunnel ventilation system, and a dewatering collection and discharge system. The tunnel ventilation system included two 42-inch diameter, 75 horsepower axial vane fans and approximately 3,100 linear feet of 42 inch diameter steel vent line. The dewatering system included: four 2,800 gallon sumps, two located at the portal, and two located in the tunnel at Stations 14+56 and 30+17; six submersible pumps, and approximately 3,100 linear feet of 6 inch diameter steel discharge line.

#### 2.3 CHANGES DURING CONSTRUCTION .

While there were a number of minor changes during the course of the contract, there were only four substantial changes which affected the final configuration of the project. Of these four significant changes, two were contractor initiated, one was Owner initiated, and one was due to differing site conditions.

#### 2.3.1 Contractor Initiated Changes.

The first contractor initiated change dealt with the 6 inch discharge line from the adit portal to the Salt River. The contract required that a 6 inch spiral weld steel pipe with Victaulic couplings be installed on the ground surface from the portal to a discharge point in the Salt River, which the contractor was required to maintain during the life of the contract. The contractor proposed changing this to a buried 6 inch PVC pipe in place of the above ground steel pipe. While the installation cost to bury the line was higher than the above ground installation cost, there were savings in material and line maintenance expenditures realized for the duration of the contract, and for future contracts as well. This made the revision virtually a nocost change for the Government and it was accepted on that basis.

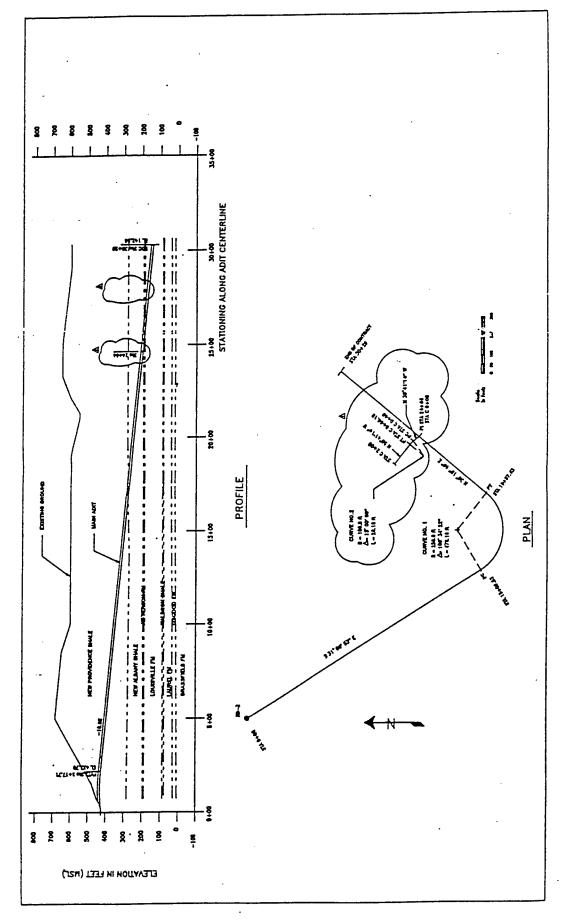


Figure 2-8. Revised Cal Adit Plan & Profile.

The second contractor initiated change involved substituting a 6 inch thick wire reinforced concrete invert in the shale formations for the 1 foot thick gravel invert specified. The contractor proposed this revision as a no-cost change, noting that the increased cost for the concrete invert would be offset by a savings in increased mining production and reduced maintenance of the tunnel invert. The change to a concrete invert in the shale formations was accepted by the Government.

#### 2.3.2 Owner Initiated Change.

As plans for the overall test configuration for the UTP test bed were developed further, the Government found it necessary to relocate the Calibration Adit to accommodate the overall test objectives for the UTP. The Government initiated a design change which relocated the Calibration Adit from Station 28+00 with a bearing of S80°41'14"E to Station 24+64 with a bearing of N35°41'14"W. The change also eliminated the 100 feet of 8 foot by 8 foot drift and replaced it with a additional 100 feet of 12 foot by 13 foot drift and 10 feet of 10 foot diameter shaft. Figure 2-8 shows the alignment changes and Figure 2-9 on the next page depicts the Calibration Adit and Charge Shaft details.

This change was negotiated with the contractor, but it was never implemented due to the more sweeping changes in the scope of the project necessitated by the differing site condition at Station 18+54.

#### 2.3.3 Differing Site Condition .

On June 25, 1993, when the tunnel heading was at Station 18+54, detectable levels of methane gas were encountered. The contractor immediately ceased mining operations, withdrew the roadheader from the face, and instituted a gas monitoring program to determine the extent of the gas inflow. Over the course of the next several days, the gas monitoring program indicated that while the flow of explosive gas was sporadic, varying from zero to greater than 20 percent of the Lower Explosive Limit (LEL) of methane, it was continuing, and exceeded the OSHA limits. This necessitated a change in classification of the tunnel from "non-gassy" to "gassy". The revision in tunnel classification required that the mining equipment, ventilation equipment, and electrical equipment be changed to comply with the more stringent requirements for gassy tunnels. Over the next several months, various alternate plans to continue the project were evaluated on the basis of UTP requirements, safety compliance, constructibility, and cost and schedule impacts.

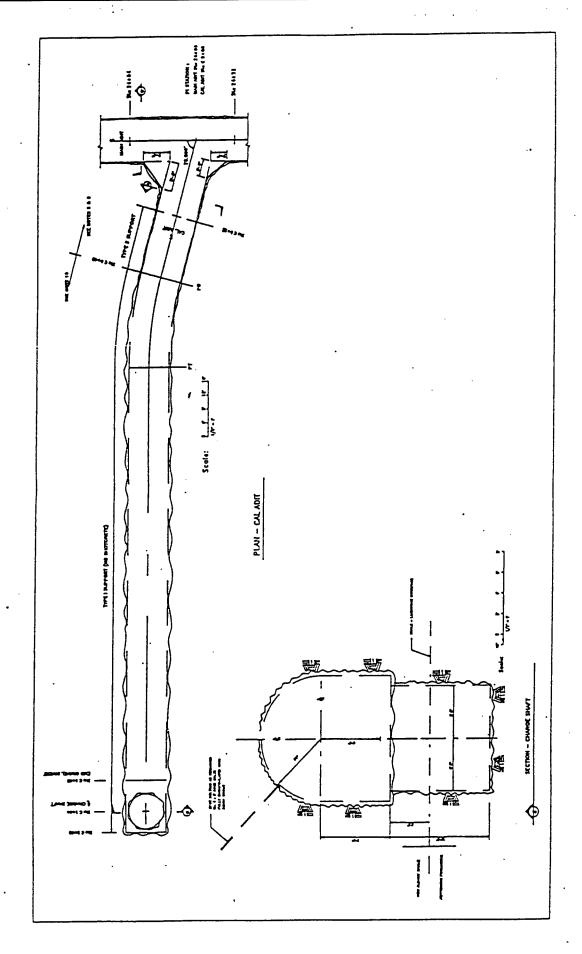


Figure 2-9. Revised Cal Adit.

A ventilation expert from the Bureau of Mines, and additional safety personnel from the DNA Field Command, Las Vegas, were brought in to assist in the development of the alternate plans for the completion of the test adit construction contract. Based on an evaluation of the alternate plans available, and an extensive review of the overall UTP requirements, DNA directed that the adit construction be terminated at Station 18+54. DNA also directed that the gas producing portion of the tunnel had to be sealed with a containment plug and pressure grouting, similar to that utilized at the Nevada Test Site (NTS), and that a 12 foot wide by 13 foot high test adit be constructed parallel to and below the existing main adit. As a result of this determination, the following changes were implemented:

- The existing ventilation system was upgraded by replacing the non-explosion-proof fan with an explosionproof fan.
- A continuous gas monitoring system with remote sensors was installed and interlocked to the tunnel lighting and mine power feed systems.
- 3. The gas inflow was isolated from the work area with concrete slab and vent pipes connected to a main vent line. Figure 2-10 on the next page shows this arrangement.
- 4. A containment plug was installed from Station 17+70 to Station 18+00 utilizing the NTS grout mix and a pressure grout containment plug (see Figure 2-10).
- 5. 524 feet of a 12 foot wide by 13 foot high test adit was constructed starting at the main adit Station 16+00 and progressed on a 0.5 percent slope up and back toward the portal on a parallel heading, 100 feet north of the main adit. Figure 2-11, which follows, provides an as-built plan and profile for this revision.
- 6. The main adit from Station 18+54 to Station 30+29 was deleted.
- 7. The electrical substation at Station 29+73 was deleted and the permanent electrical distribution in the tunnel was revised.
- 8. The dewatering sump at Station 30+17 was eliminated and the 6-inch tunnel discharge line was terminated at the dewatering sump at Station 15+00.
- 9. The Revised Calibration Adit at Station 24+54 and charge shaft was deleted.

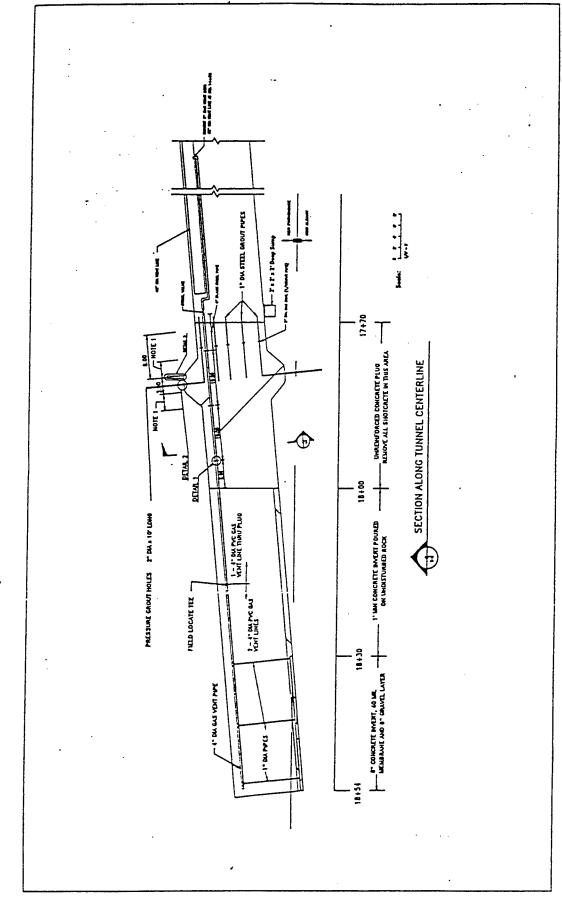


Figure 2-10. Gas Containment Plug.

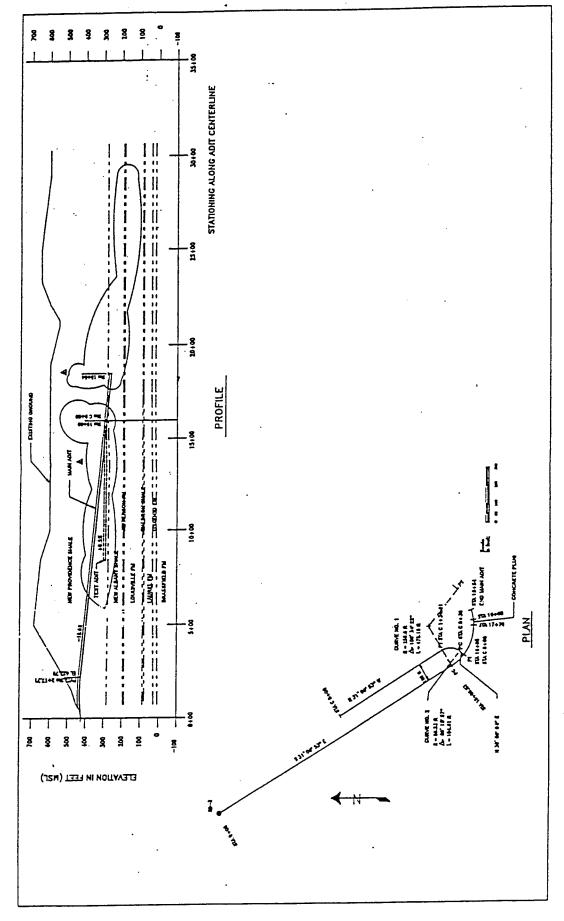


Figure 2-11. As-Built Plan & Profile.

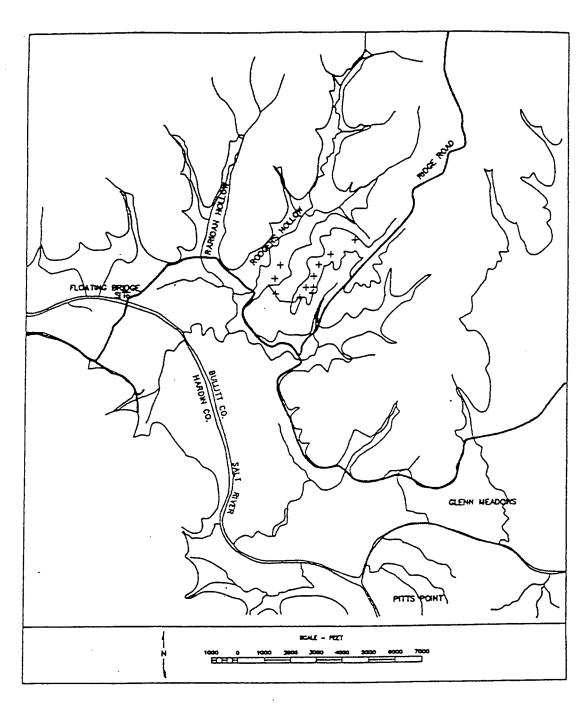


Figure 3-1. Rodgers Hollow Area.

#### SECTION 3

## GEOLOGY

## 3.1 GENERAL SITE AREA .

The UTP project area lies beneath a ridgeline and immediately east of a small tributary valley to the Salt River on the northern end of Ft. Knox. A map is provided in Figure 3-1, as well as earlier in Figure 1-1. The portal for the adit was excavated on the lower hillslope of the ridgeline, just above the slope break to the valley, which is called Rodgers Hollow. The Rodgers Hollow area is characterized by a relatively flat valley floor surrounded by hills on three sides. The area is drained by a small unnamed creek that branches into two forks in the northern portion of the hollow. This creek flows into the Salt River approximately 0.6 miles southwest of the entrance of Rodgers Hollow.

The overburden material in Rodgers Hollow consists of quaternary alluvium and lacustrine deposits; generally light-tan to dark-brown silts and clays with varying amounts of sand, gravel, and rock fragments. Zones of gray to olive-gray silty clays are commonly encountered in an intermix with the brownish material. The overburden slopes toward the drainageway in the hollow and nominally parallels the ground surface contours. In many areas of Rodgers Hollow, the water table is 2 to 6 feet below the ground surface.

The bedrock at the portal elevation is shale that is a part of the Mississippian-age Borden formation. The portal was constructed at the boundary between the upper shale member of the Borden Formation, the Nancy Member, and the underlying New Providence Shale Member (see Figure 3-2 on the next page). At this site, the Nancy and New Providence Members are essentially indistinguishable, although the silt content of the Nancy Shale is known to be slightly higher than that of the finer grained, underlying New Providence Shale. The general hillslope, above the slope break to the valley, has a minimal soil profile and a weathered zone approximately 20 to 30 feet thick. Because the New Providence and Nancy Members of the Borden Formation are so impervious to water, the depth of weathering usually does not exceed 30 feet below the ground surface.

The Nancy Member Shale base lies at the portal elevation and is approximately 150 feet thick, so that under the main portion of the ridgeline, the Nancy Shale overlies the adit for a considerable thickness. The New Providence Member Shale continues 180 feet beneath the portal. Another 80 feet of shale thickness, the New Albany Shale, exists below the New Providence, making the total

SYSTEM	SERIES	GLACIATION	YOU	MEMBER, AND BED	LITHOLOGY	THICKNESS (FT)
QUATERNARY	PLEISTOCENE	ILLINOISIAN	A O	USTRINE, LOESS LDER ALLUVIUM		0-85
TERTIARY 1 & QUATERNARY	PLICENE ! &	•		TERRACE DEPOSITS		0-90
				ST. LOUIS LIMESTONE		
	MERAMECIAN			SALEN LIMESTONE		DALY LOWER PART PRESIDET
			H	ARROOSBURO LIMESTONE		40
PIAN			ATION	MULDRAUGH MEMBER		<b>60</b> –70
MISSISSIPPIAN	OSAGEAN		FORMATION	NANCY MEMBER		180
Σ	KANDERHOOKIAN		BORDEN	NEW PROVIDENCE SHALE MEMBER		180
	MIDDLE &			YHABIA WƏN BIAHR		78
DEVONIAN	UPPER DEVONIAN		J	FFERSONVILLE		7-9
RIAN	HACARAN			LOUISVILLE		102
SILURIAN			=	LAUREL		45
	L	<u> </u>	ــــــــــــــــــــــــــــــــــــــ			

Figure 3-2. Strategraphic Column of Ft. Knox UTP Area of North Central Kentucky.

aggregate thickness of shale above and below the portal elevation greater than 300 feet. Beneath the New Albany are the initial test target carbonates of the Louisville Formation.

The uppermost hillslopes, just below the ridge line, are also predominantly shale, yet they actually classified as shaley siltstone with minor beds of limestones, dolometic siltstones, shales, and sandstones. The materials are of the Upper Borden Formation (Muldraugh Member). The ridge-capping materials consist of the Harrodsburg and the overlying Salem Formations. All the hillslope and ridgeline materials are of Mississippian age. The stratigraphic relationship and thicknesses of the rocks of this area of Ft. Knox are shown in the stratigraphic column on Figure 3-2 opposite.

The valleys bordering the test site ridge have been formed by erosional processes of the tributary streams; however, the valleys in the vicinity of the test site have also been affected by a major glacier advance during the Illinoisan Ice Age which occurred approximately 200,000 years ago. Glaciers advanced to within 50 miles of the site area. The advance, along with the climate effects associated with the glacial period, caused substantial erosion and alteration to the existing drainage of the area, including the rerouting of the ancestral Ohio River from a more northerly position to the one now currently occupied (Reference 1) as shown in Figure 3-3 on the next page.

The ice advance caused the pooling of water in many very large areas, including a huge temporary lake in the vicinity of Louisville, which encompassed Rodgers Hollow and the nearby valleys. This led to the deposition of some very low-strength lacustrine (lake bed) silty clay units in the valleys. The weak lacustrine deposits associated with the valleys were not a factor in the adit design and construction because they exist at elevations below the portal, and are present only within the valley boundaries.

#### 3.2 ADIT GEOLOGY.

A geologic profile along the adit centerline is shown in Figure 3-4 which follows. The adit portal materials consist of the basal Nancy Member Shales and upper New Providence Shales of the Borden Formation. As the adit penetrates deeper, the New Providence Shale, while appearing lithologically quite consistent, has a gradual decrease in the fine-grained, granular quartz content with increasing depth. The contact with the underlying New Albany Shale is obvious, as it is where the dark gray shales of the New Providence give way abruptly to the dark brown shales of the New Albany. The New Albany is a more competent shale than the New Providence, although it is less dense because of the high

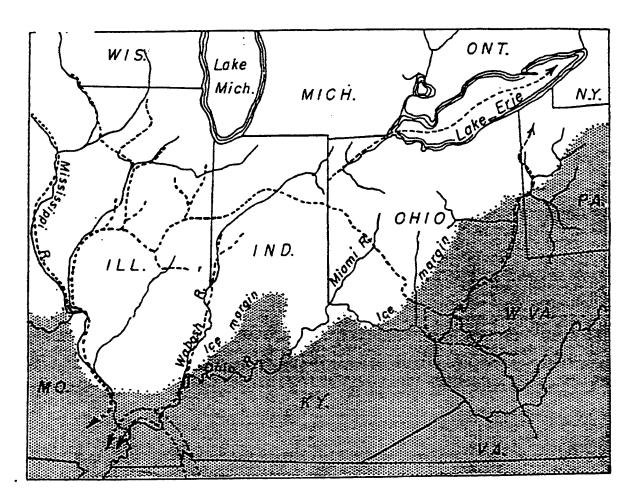


Figure 3-3. Maximum Advance of Glaciers In Ft. Knox Revion.

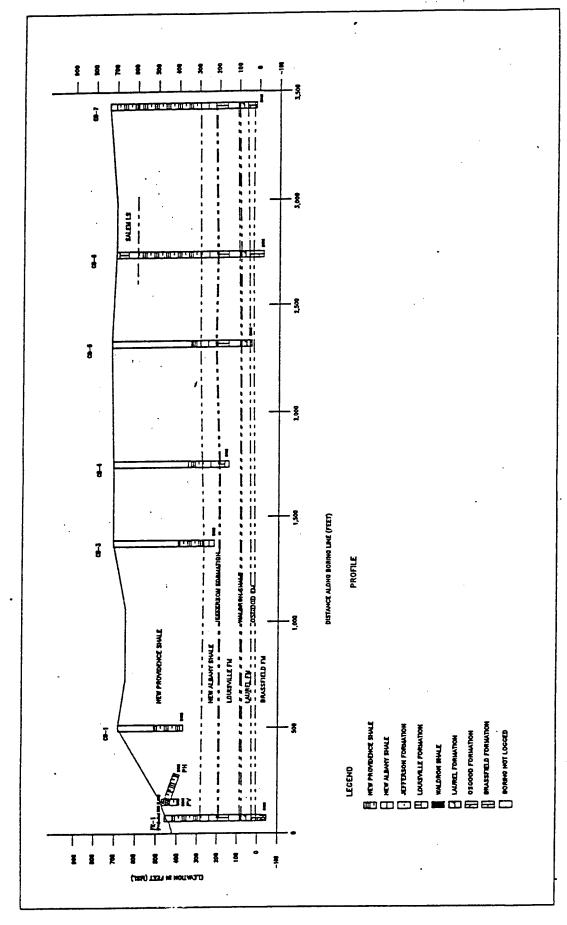


Figure 3-4. Geologic Profile Along Adit Centerline.

percentage of kerogen (organic material) it contains.

Below the New Albany there is an equally recognizable transition to the important carbonate (limestones and dolomites) section of the uppermost carbonate formation horizon. The Jeffersonville limestone which varies in thickness through the test area from 6 to 9 feet. Beneath the Jeffersonville is the 100 feet thick Louisville Carbonate Formation. The Louisville is difficult to distinguish from the overlying Jeffersonville, unless it is tested by applying hydrochloric acid. The Jeffersonville is mostly limestone (calcite (CaCO<sub>3</sub>)) while the Louisville is predominately dolomite (Ca, MgCO<sub>3</sub>). However, there are zones within the Louisville which are rich in calcite and can be classified as limestone, hence, the term Louisville Carbonate was chosen.

Since the adit was never intended to penetrate below the Louisville Formation, the deeper formations (Laurel, Osgood, and Brassfield), which were penetrated by the exploratory borings, are not described herein.

#### 3.3 FIELD EXPLORATION PROGRAM .

The geotechnical characterization of the UTP project site consisted of field explorations and testing. The purpose of the explorations was to provide the factual data to characterize the site for testing purposes, and to identify the geotechnical conditions expected during excavation of the portal and adit, including the geologic formations, rock type and condition, and the anticipated ground water conditions which had to be addressed. To accomplish this task, four geologic exploration techniques were used: core drilling; hydrologic testing and water sampling; geophysical logging; and formation gas detection.

The exploration activity was chronologically subdivided into four different phases. These were: 1) site-selection, 2) adit lay-out, 3) groundwater monitoring and testing, and 4) formation gas detection. Ft. Knox was only one of a number of sites considered during Phase 1, site selection, and the last of this work was accomplished during calendar year 1990. Phases 2, 3 and 4 were accomplished only for the Rodgers Hollow site, and were conducted concurrently during the calendar year 1991. Additional exploration activities classified under phases 2 and 3 were conducted during the construction of the test adit in the calendar years 1992 and 1993.

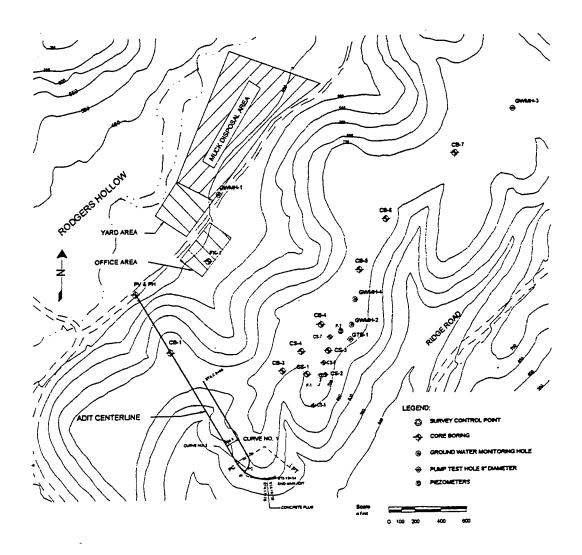


Figure 3-5. New Site Plan With All Borings Shown.

## 3.3.1 Core Drilling.

A total of 15 NQ and NX core borings were drilled and logged as part of the preconstruction exploratory program developed for the UTP. During the site selection (Phase 1) of this project, two borings, FK-1 and FK-2 were cored with NQ wireline equipment, each to a depth of 500 feet. This work was performed under contract for WES using a Failing 500 drill rig. Site-specific explorations (Phase 2) to lay out the adit and define the anticipated tunneling conditions included borings CB-1, CB-3, CB-4, CB-5, CB-6, and CB-7 (boring CB-2 was not drilled). Explorations conducted to define the conditions at the portal location included one vertical and one angle boring, designated PV and PH respectively. All of the Phase 2 drilling was performed by U.S. Army Corps of Engineers drill crews. Five additional borings, GWMH-1, GWMH-2, GWMH-3A, and GWMH-4 were cored as part of Phase 3 groundwater monitoring program. All of these holes were drilled by the Corps of Engineers using HQ wireline equipment. Boring GWMH-3A was logged only by the geophysical surveys, and GWMH-4 was not logged at all.

During the Test Adit Construction phase of the UTP, an additional exploratory program was carried out in December 1992, and in May 1993, in which a total of 9 additional borings were drilled and logged. Piezometers were later installed in five of these borings (P-1, P-2, CS-5, CS-6, and CS-7) and in two of the previous borings (GWMH-2 and GWMH-4). The boring locations are shown on Figure 3-5 on the opposite page and the logs of the borings are presented in Appendix A.

## 3.3.2 Geologic Discontinuities.

Based on data obtained from the preconstruction exploratory borings and other available geologic data available, it was concluded that no faults or shears would be encountered. It was also concluded that bedding plane joints, which are horizontal to moderately inclined, would comprise the majority of joints encountered.

Discontinuities in the New Providence Shale are typically planar, tight to moderately tight, horizontally oriented (0° to  $10^\circ$ ) with smooth to slightly rough surfaces and with a few occurrences of soft clay fillings. The discontinuities are mostly unweathered. The New Albany Shale, on the other hand, has steeper discontinuities (0° to  $40^\circ$ ), with occasional calcite and pyrite fillings. The joints are planar, slightly rough to rough-surfaced, moderately tight to tight, and unweathered. The Louisville Carbonate Formation typically has a higher frequency of discontinuities than both the New Providence and New Albany Shales. Discontinuities here are steeper (0° to  $50^\circ$ ), and are open. Calcite fillings are frequent along the joints. Weathering of discontinuities in the Louisville Carbonate Formation is more

evident.

Geologic mapping of main and test adits confirmed the exploratory data obtained for the New Providence Shale. In accordance with the exploratory data, no shears or faults were encountered and only five open and bentonite-filled joints were encountered. All of these were encountered in the first 141 feet of main adit, close to portal (Station 0+94 to Station 2+34). Every one of these discontinuities were transverse and vertically oriented (252° to 263° Azimuth strike and 75° to 85° NW dip direction).

There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62. Their measured Azimuth strikes ranged from 305° to 335° except for the bedding plane at Station 17+65 which had a 285° Azimuth strike. Dip angles for these planes were 6.5° to 9° NW direction except for the plane at Station 17+65 which had a SW dip direction.

Since all of the explorations, other than portal boring PH, were drilled vertically, exploratory data would be biased against high-angle fractures, and the exploratory borings data for the New Albany Shale and the Louisville Carbonate Formation may not be representative of what might be encountered in the adit when tunneling into these strata.

# 3.3.3 Hydraulic Testing and Water Sampling.

The UTP site-selection criteria required that the final experimental test bed be located in a water-saturated, carbonate rock. The hydrologic properties of the Louisville Formation are important characteristics, not only for test bed predictions, but also for anticipating ground water conditions during construction. To that end, a program to establish and define the hydrologic nature of the site was developed and consisted of:

- Constant head tests using downhole packer injection to establish rates of flow and hydraulic conductivity by depth interval.
- Water sampling to determine water quality.
- 3. A long-term (25-hour) pump test to determine the ability to draw down the primary aquifer at the site (Louisville Carbonate Formation).

The injection (pump in) tests were conducted in seven of the NQ boreholes to determine the volume of water required to maintain a constant head.

Table 3-1. Summary of Aquifer Water Quality .

<u>ANALYSIS</u>	RESULTS
Conductivity	27,000 micro-omhs
ph	7.01
Total Alkalinity	456
Chloride	11,535 mg/l
Calcium	588 mg/l
Magnesium	336 mg/l
Sodium	5,620 mg/l
Hardness (CaCO <sub>3</sub> )	2,820 mg/l
Total Dissolved Solids	16,500 mg/l

Determining the quality of the groundwater present in the Louisville Formation was an important consideration in the planning of the UTP Test Adit Project. An uncontaminated water sample was obtained from boring CB-6 and chemically tested. The results of the laboratory test are reported in Appendix B.3 of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) and are provided in Table 3-1. Due to the high chloride content of the groundwater, it was necessary to make special provisions in the contract to pipe the tunnel discharge water to the Salt River and to specify minimum dilution factors for its discharge into the river.

The long term pump test was performed using a large diameter boring, denoted as borehole GTB-1. An 8-1/2 inch diameter hole was drilled with an air hammer to a depth of 102 feet, and a 6 inch diameter PVC pipe was set in place and sealed with Bentonite. The remainder of the hole was then drilled with a 6 inch diameter air hammer button bit to a total depth of 640 feet. Detailed results of this test were reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) Tables 3-2 and 3-3 on the following page summarize the results from the active and passive pumping phases of the pump test performed at boring GTB-1.

Based on the data obtained through the hydraulic testing program conducted at the site, it was established that the porosity in the carbonate material, known in many situations to be laterally variable, exists only on a minor scale in the immediate vicinity of the Louisville Carbonate Formation of interest. Furthermore, the Louisville Formation water reservoir could be considered isotropic in properties and in extent. The two distinct porosity zones of the Louisville Carbonate Formation, the upper and the lower porosity zone, appear to be both laterally continuous (at least in the area of the program borings), as suggested by their presence in each well of the pump test program. Also, only partial water level recovery was achieved in a 24 hour period after pumping. This suggests that the extent of the aquifer is limited.

Using the characterized coefficient of transmissibility in the vicinity of borings GTB-1 and GWMH-2 as 750 to 1120 gpd/ft (100 to 150 ft³/day/foot), as reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) and using 74 feet as the nominal aquifer thickness, the equivalent hydraulic conductivity would be 1.35 to 2.03 ft/day. Assuming a steady-state drainage for both the borehole and the adit under a constant water head of 270 ft, the tunnel was estimated to produce about 510 to 766 Ft³ of water per day per foot of length in the aquifer (see Appendix B.2). This translates to approximately 2.6 to 4.0 gpd per foot of adit. Since the adit was designed to have a 10 percent downward grade, the 74 feet of aquifer translates to approximately 740 feet of aquifer zone penetration. The resulting total flow within the Louisville

Table 3-2. Coefficients of transmissibility and storage, Active Pumping Phase GTB-1.

WELL TEST	RANGE FROM GTB-1 (FT)	COEF TRANS (T) GPD/FT	COEF STORAGE (S)
GWMH-2	121	676	3.60
GWMH-4	320	1650	1.34
CB-5	540	663	1.75
CB-6	960	539	1.90
FK-1	1250	499	1.53
GWMH-1	1520	. 580	0.92
CB-7	1590	434	0.61
GWMH-3A	2090	868	0.48

Table 3-3. Coefficients of transmissibility and storage.
Passive Recovery Phase GTB-1.

WELL/TEST	COEF TRANS (T), GPD/FT
GWMH-2	729
GWMH-4	1600
CB-5	1422
CB-6	1307
FK-1	937
GWMH-1	904
CB-7	1114

aguifer was calculated to be 1,925 to 2,960 gallons per day.

# 3.3.4 Geophysical Surveys.

Geophysical wireline logging was conducted in each of the core borings drilled at the site in the preconstruction exploration phase, except for the portal area borings (PV and PH) and the air drilled boring (GTB-1). Various types of geophysical logs were performed during this program. All logs were run in the open hole within several months of the completion of the drilling of each hole. The types of log runs, the principle of measurement, the recorded parameters of each log type, and the results of the logging are summarized in Section V of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2).

## 3.3.5 Formation Gas Detection .

In an attempt to detect the possible presence of formation hydrocarbon and/or hydrogen sulfide ( $H_2S$ ) gases, a "mud logging" unit was employed during the air drilling of boring GTB-1 in July, 1991, to monitor the returning air stream in order to determine the presence and concentration of either or both of the gases.

The hydrocarbon gas detection involved the use of two instruments, a total hydrocarbon gas detector, and a gas chromatograph unit. The total hydrocarbon gas detector that was utilized on the UTP logging is commonly referred to as a thermal conductivity detector (TCD). This unit provides a continuous measurement of the presence and level of total combustible gases either within the flow stream, as in the case of air drilling, or emanating out of solution from the recirculating mud stream. The gas chromatograph, uses discrete samples, separating the mixture into its component gases, and then samples each component. In this way the device can determine the type, such as methane (CH4), ethane (C2H6), propane  $(C_3H_8)$ , butane and/or isobutane  $(C_4H_{10})$ , and pentane  $(C_5H_{12})$ , and concentration of each component gas within. Methane (CH4) gas was The total hydrocarbon in borehole GTB-1. concentration was measured and recorded, as well as an independent methane concentration level. The results are presented in Figure 3-6 on the following page.

Figure 3-6 also shows the data recorded from the hydrocarbon gas detectors adjacent to the lithologic log and stratigraphic column. There was no gas was detected through the entire Borden Shale section of the hole. The first detection of gas corresponds with the drill bit penetration into the top of the organically rich New Albany Shale, and the sustained high readings matched almost perfectly with the interval within the New Albany Shale which has the highest natural gamma ray activity on the geophysical log. In

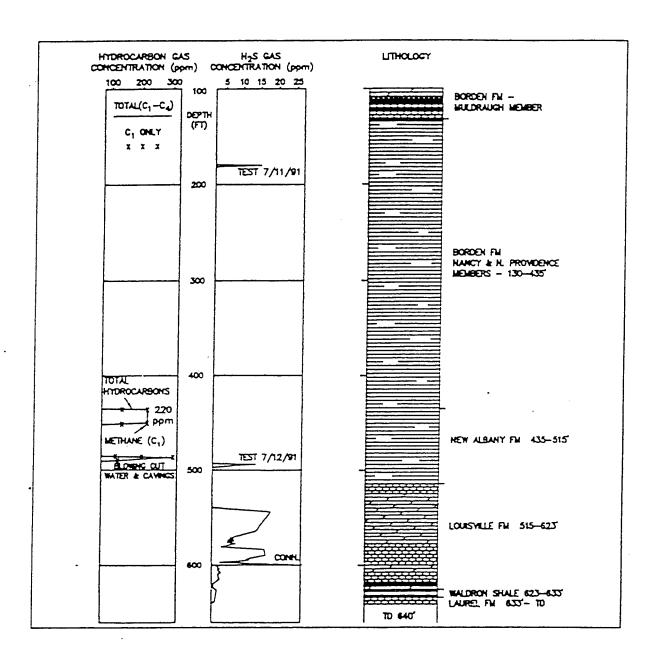


Figure 3-6. Formation Gas Log for Boring GTB-1.

previous studies, this interval has been shown to possess the highest organic material content in the form of kerogen as well (Reference 7.2 in GEOTECH REPORT). Samples of this material have been triaxially tested in the laboratory and have been observed to release hydrocarbon gas after testing. Based on the formation gas detection operation, it was determined that small quantities of methane ( $CH_4$ ) gas may be encountered as the adit is driven through the upper portion of the New Albany Shale.

The presence of hydrogen sulfide ( $\rm H_2S$ ) gas in the UTP adit was another concern since it could represent a serious hazard to personnel. In an attempt to detect the presence and measure levels of hydrogen sulfide gas, two types of sensors, one active (Metal Oxide Detector) and one passive (Lead Acetate Paper), were employed to monitor the exit air stream while drilling borehole GTB-1. The data obtained from that monitoring program is displayed adjacent to the lithologic log and stratigraphic column in Figure 3-6 It can be clearly seen that the occurrance of  $\rm H_2S$  corresponds to the upper porosity zone in the Louisville Formation.

The formation gas monitoring project resulted in the detection of both hydrocarbon and hydrogen sulfide gases. Each was identified in distinct and isolated intervals.

During construction of main adit, methane (CH<sub>4</sub>) gas was encountered in the top 2 to 3 feet of the New Albany Shale, as gas perculated from two 0.1-inch wide, calcite filled, open vertical joints in the New Albany Shale in the adit invert at approximate station 18+50. Analysis of the air/gas samples taken revealed that the emitted gas was 98 percent methane (CH<sub>4</sub>) with the remainder being primarily carbon dioxide (CO<sub>2</sub>) and ethane (C<sub>2</sub>H<sub>6</sub>). Concentrations for samples taken at adit face were 24 ppm of CH<sub>4</sub> on the left side, 463 and 155 ppm CH<sub>4</sub> at center (2 samples), and 64 ppm CH<sub>4</sub> at right side. Hydrogen sulfide gas was not encountered, since no tunneling in the Louisville Carbonate Formation was performed.

## 3.4 UNDERGROUND GEOLOGIC MAPPING .

The Full Periphery Method (developed by the U.S. Corps of Engineers) was adopted for mapping the underground geology encountered in the excavation of the adit. The mapping indicated that the New Providence Shale was massive with few discontinuities. Five vertically oriented, bentonite filled joints were encountered in the first 50 feet of the main adit excavation. Another set of tight, mostly vertical joints was encountered between Station 2+29 and Station 2+35. As noted in Section 3.3.2, There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62.

Cobble-size siderite intrusions occurred frequently throughtout the New Providence Shale and one 8 inch thick siderite dike was encountered in the main adit from Station 15+64 to Station 16+54 and continued on in the test adit to Station C 3+10. The New Providence Shale started displaying organic laminar deposition patterns at about Station 15+00, where shale started to have horizontal bands of olive-green to grayish green coloration that became increasingly dominating and distinct as excavation advanced deeper into the New Providence Shale towards interface with the dark brown colored New Albany Shale (encountered at Station 15+34). Detailed geologic maps are presented in Appendix C.

## 3.5 SITE HYDROGEOLOGY .

The test site selection criteria required a saturated carbonate section at the test depth, therefore, a discussion of the hydrology of area becomes necessary to complete the description of the geology of site area. Two hydrologic regimes are discussed, the soil water, and the water within the rock units. Please refer to Section 3.3.3, Hydraulic Testing and Water Sampling, for details of hydrological testing performed for the UTP.

## 3.5.1 Soil Water.

The valleys contain a shallow perched water table. Boreholes drilled at various locations within the Rodgers Hollow area, below the grade change controlled by the weathering of the rock slopes, all indicated the presence of the shallow water table. The recorded piezometric levels showed a remarkable seasonal dependence. For example, the water table at a site a small distance up the valley from the portal area had been observed at a depth of 2 to 4 feet below the surface in February to April, and as deep as 9 or 10 feet in August through early November. This perched aquifer exists only at elevations within the valley proper and below the portal elevation, so that it should not be a factor in either portal construction or within the adit.

## 3.5.2 Rock Hydrology.

The hydrology of the rock materials affects the design parameters of the adit construction. For the purposes of this discussion, the rock hydrology will be divided into three zones: the Shale Zone; the Louisville Carbonate Zone; and the Deep Zone, i.e. the Waldron Formation into the Laurel Dolomite (Laurel Zone).

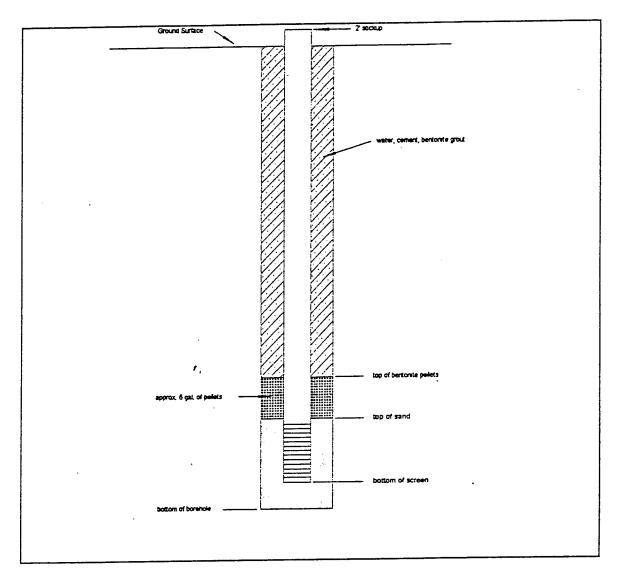


Figure 3-7. Typical Profile of Installed Piezometers.

- 3.5.2.1 <u>Shale Hydrology</u>. All of the shale units encountered above the Louisville Carbonate give evidence of 100 percent water saturation. However, no noticeable water flow has been encountered while drilling within the Borden or New Albany Shales. Thus, from a hydrologic engineering standpoint, only minor water seepage would be expected while tunneling through the shales.
- 3.5.2.2 <u>Louisville Carbonate Hydrology</u>. Two zones of water flow within the Louisville Carbonate have been detected and hydrologically tested. The upper zone is variable in thickness, but the base of the zone lies 35 to 40 feet below the base of the New Albany Shale. This zone is identified as the major water producing zone of the site. The lower water-bearing zone of the Louisville lies approximately 20 feet above the underlying Waldron Shale. This zone is also variable in thickness and permeability, but can generally be classified as less water-productive than the upper zone.
- 3.5.2.3 <u>Deep (Laurel) Hydrology</u>. The only recognized potential water zone below the Louisville Carbonate at the site is a zone within the Laurel Dolomite. There is relatively little known about this zone since it lies below the depth of interest for testing. Where this formation was penetrated by boreholes, it was found that it is located about 15 feet below the base of the Waldron Shale at approximately the 650 feet depth (as encountered in boreholes CB-5 and CB-6). The fluid conductivity/temperature geophysical logs do not demonstrate significant fluid entry from this zone, although the reservoir properties suggest it could be a water-bearing strata of minor to intermediate importance.

#### 3.6 HYDROLOGIC MONITORING .

A total of seven piezometers were installed in 1993 during construction of the test adit by the WES crew at boreholes GWMH-4, GTB-1, P-1, P-2, CS-5, CS-6, and CS-7 to monitor the water table in the Louisville Formation Reservoir, prior to and during the penetration of the main adit. The data collected provided quick and accurate feedback on depletability, drainage profiles, and the pressure drop of the reservoir as the main adit was constructed, and also provided the means necessary to determine if remedial steps were needed to be implimented so that the saturation of the Carbonate Formation could be maintained as required by the test parameters. A profile of a typical piezometer installation is shown in Figure 3-7 at left, and the locations of the piezometers are shown in Figure 3-8 on the next page.

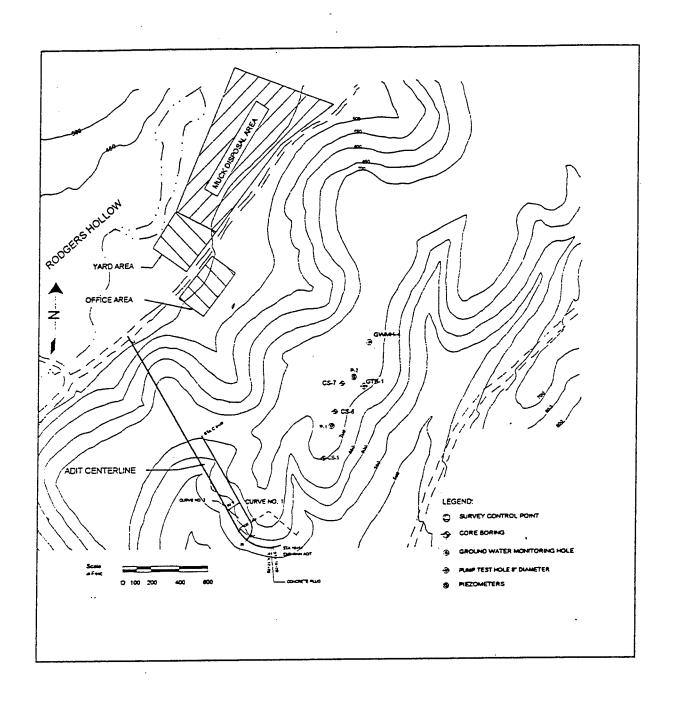


Figure 3-8. Location Map of Installed Piezometers.

#### SECTION 4

#### CONSTRUCTION METHODS

#### 4.1 GENERAL .

A Request for Proposals (RFP), Solicitation No. DACA27-92-R-003 Underground Technology Program, Test Adit Construction, was issued in May, 1992 by the U.S. Army Engineer District, Louisville. A total of ten proposals were received in June, 1992 and, after evaluation of the proposals, a contract was awarded in July, 1992 to W.L. Hailey & Co., Inc. of Nashville, Tennessee. The contract provided for a one year construction period for the completion of the test adit and all appurtenant features of the permanent work.

The contractor began mobilization at the site in early August, 1992 and completed the initial site work, office set up, and site preparation, on October 20, 1992. Portal construction commenced on October 13, 1992, with the clearing of the portal area and the backfill of the structure was completed on December 23, 1992. Tunnel excavation commenced on December 28, 1992, and progressed to Station 18+54 on June 25, 1993, at which time methane gas was encountered in the heading and the tunnel excavation was halted. Work in the tunnel resumed on November 8, 1993, with the installation of vent line hangers in the main adit. The gas collection system was installed between November 15 to November 18, 1993 and the containment plug was constructed between November 22, 1993 and February 28, 1994. The test adit was excavated concurrently with the containment plug construction between November 22, 1993, and February 11, 1994. The balance of the contract work, electrical, mechanical, invert placement, shotcrete lining and final tunnel clean up was performed from March 1, 1994 through May 7, 1994.

## 4.2 PORTAL CONSTRUCTION .

The portal construction involved an open cut excavation of both overburden and shale. The overburden material was excavated using a dozer, loader, and dump trucks. The side slopes of the overburden excavation were laid back, thereby eliminating the need for the support of excavation structure. The shale cut was excavated utilizing drill and blast methods to break the rock, and a loader and dump trucks to excavate the shot rock. The side slopes of the rock cut were excavated with a slight outward batter to eliminate the need for any rock support.

# UTP TUNNEL EXCAVATION WEEKLY PROGRESS

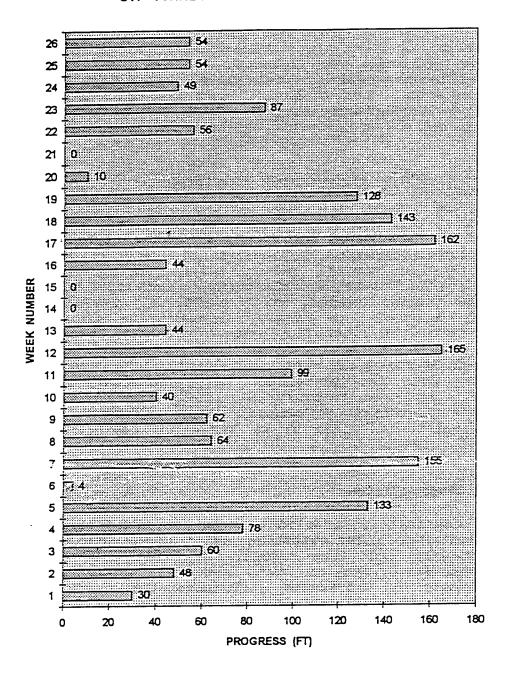


Figure 4-1. Tunnel Progress Summary, (Chart 1 of 2).

After completion of the excavation, the steel ribs (W6x25s) were installed and the concrete invert poured. The 6 inch thick wire reinforced shotcrete was then placed between the ribs and the structure was backfilled. The reinforced concrete U-Wall structure was built by normal cast-in-place methods with wood forms.

#### 4.3 ADIT EXCAVATION .

Tunneling operations commenced on December 28, 1992, at Station 0+94 using a Voest-Alpine Roadheader to mine the shale, and a pair of 5 cubic yard Eimco low profile mine trucks were used for muck removal. The contractor selected this type of equipment for excavating the the shales because it provided a more continuous mining operation. This method significantly reduced overexcavation, and eliminated many of the safety hazards that are inherent in a drill and blast operation.

Throughout the tunnel excavation, the contractor mined the required cross section with minimal variance, and maintained line and grade well within tolerances. The roadheader and heading crews limited overexcavation and minimized the disturbance to the rock beyond design line. However, the actual advance rates for the roadheader operation never approached the anticipated rates. The estimated production rates for the roadheader excavation were an average of 15 linear feet of advance per 8 hour shift after an initial startup period. The contractor was prepared to mine two shifts per day and use a third shift to install ground support and tunnel utilities, as well as maintain the mining equipment. In this way, he had planned to mine and support an average of 30 linear feet per day, or 150 linear feet of tunnel per five day work week.

In the period from December 28, 1992 to June 25, 1993, the contractor worked a total of 141 days and mined 1,760 linear feet of adit. The overall average for this period was 12.5 feet per day and 67.7 feet per week. There were only six weeks in which production levels exceeded 100 feet per week, and the best weekly production was 165 feet. At left, Figure 4-1, provides the weekly advance rates for the first twenty-six weeks. The rates for the remainder of the project may be found on the following page. Of the total 141 day project duration, the contractor was able to mine on 89 days, and lost a total of 52 days for the following reasons: 13 days were spent on ground support installation; 12 days due to equipment breakdowns; 12 days for concrete operations on the invert; 8 days for ventilation system installation; and 7 days due to inclement weather.

On June 25, 1993, methane gas was detected in the tunnel at Station 18+54. The quantity and duration of the gas entering the

## UTP TUNNEL EXCAVATION WEEKLY PROGRESS

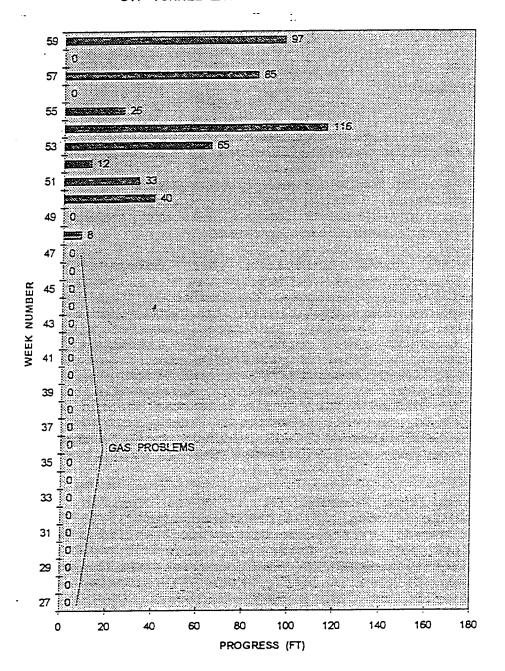


Figure 4-1. Tunnel Progress Summary (Chart 2 of 2), (Continued).

tunnel was sufficient to require that the tunnel be re-classified as a "gassy" tunnel. Mining operations were discontinued for a period of 23 weeks while alternate plans were developed to deal with the gassy conditions. As noted in Section 2.3.3, Differing Site Condition, the decision was made to terminate the main adit at Station 18+54, seal the tunnel with a gas containment plug from Station 17+70 to Station 18+00, and to realign the test adit to remain totally within the New Providence Shale.

The test adit was excavated from Station C 0+06 to C 5+24 during the period of November 22, 1993 to February 11, 1994 and utilized the same equipment and methods as the main adit. Unlike the main adit, the test adit was excavated essentially on a single shift basis, four days per week. The average production rate for the 518 linear feet of tunnel was 13 feet per day on a single shift basis, which is more than twice the advance rate achieved in the main adit. Figure 4-1, Chart 2 of 2, at left shows the weekly advance rates in the test adit.

## 4.4 GROUND SUPPORT .

As discussed in Section 2.2.5, Ground Support, there were four types of ground support provided for the contract, with the determination of which type to employ, made in the field as the excavation progressed. As anticipated, the New Providence Shale was massive and competent, and required very little direct ground support. A total of six steel sets were installed at the beginning of the adit from Station 0+94 to Station 1+18. A total of twenty-two rock bolts and twelve rock dowels were installed in the main adit from Station 1+22 to Station 2+36. The permanent support for the sump bay (Station 14+54) and transformer bay (Station 15+16) consisted of a total of 101 rock bolts, and the support of the adit intersection (Station 16+00) consisted of seventy-two rock dowels.

The only area of the main adit which required a substantial number of rock dowels was from Station 16+56 to Station 18+46. In this reach of the tunnel, the New Providence Shale had a tendency to spall and ravel at crown of tunnel when the heading face advanced two tunnel diameters further. As the excavation progressed, the New Providence Shale became more organic and displayed planar, thin, lamination layers at crown, beginning at Station 15+02. At approximately Station 16+60, spalling of rock from crown started occurring more frequently, and the size of the spalled rock fragments increased to approximately 1 foot wide by 2 foot long and 2 to 3 inches thick. Even though the shale formation was still massive and structurally self-supporting, the spalling posed a safety hazard to the workmen in the heading, and the contractor was directed to install rock dowels from Station 16+56 to the

Table 4-1. Summary of UTP-Permanent Support Utilized.

ADIT STATION	TYPE OF SUPPORT INSTALLED
0+94 to 1+18	Steel ribs (6 ea)
1+22 to 1+33	Spot rock dowels (16 ea)
1+45 to 1+51	Spot rock bolts (12 ea)
2+32 to 2+36	Spot rock bolts (6 ea)
5+68 to 5+80	Spot rock bolts
14+35 to 15+38 (Sump Bay)	Patterned rock bolts (47 ea)
14+93 to 15+38 (Transformer Bay)	Patterned rock bolts (57 ea)
15+80 to 16+20 and C 0+12 to C 0+21 (Intersection)	Patterned rock bolts (72 ea )
16+56 to 18+46	Patterned rock bolts (212 ea) (with wire mesh from 17+58 to 18+44)

face, located at Station 17+35, before any further advance of the heading. The contractor was also directed to have rock dowels installed within 15 feet of the face at all times. Therefore, patterned rock dowels were installed from Station 16+56 to Station 18+46. Table 4-1 lists the different support systems used and their location in test adit.

All rock bolts and rock dowels were fully resin-encapsulated Number 8 threaded rebar, Grade 60 steel. The typical bolt/dowel length was 8 feet except for a number of 10 foot long bolts which were used at the sump and transformer bays and at the adit intersection.

While the adits required only minimal direct ground support for safety and stability, the New Providence Shale did require a shotcrete lining to permanently seal the excavated surface to prevent long-term deterioration of the shale due to air slaking. A nominal 2-inch thickness of shotcrete was applied throughout the entire length of both the main and test adits, and a 4 inch thickness was applied to the intersection area of the two adits.

#### 4.5 GROUNDWATER OCCURRENCES .

The only measurable water inflow encountered during tunneling was at the top of the New Albany Shale at Station 18+50. While the water inflow, estimated at less than 5 gpm, presented no problem to the excavation, the water was accompanied by methane gas. The impact of the methane gas is discussed in detail in Section 2.3.3, Differing Site Condition.

#### SECTION 5

## TUNNEL INSTRUMENTATION

## 5.1 TAPE EXTENSOMETERS.

A total of six sets (four points each) of convergence points were provided in the bid schedule. These convergence points were to be installed as needed in the main and calibration adits to monitor movements of the tunnel lining in areas where the geological conditions warranted. Due to the massive nature of the New Providence Shale, only one set was required, and the instrument was installed in the main adit at Station 1+20 to monitor any movement close to the portal. A total of four readings were taken in the period from February 3, to February 8, 1993. The data obtained from these readings indicated that the movements were negligible and stabilized quickly.

# 5.2 SINGLE POINT BOREHOLE EXTENSOMETERS .

None of the six sets of Single Point Borehole Extensometers (SPBXs) that were provided for in the contract were required in the New Providence Shale, and none were installed.

## SECTION 6

#### REFERENCES

- 1 Pitts Point Geologic Quadrangle Map, USGS Publication, 1976.
- 2 <u>UNDERGROUND TECHNOLOGY PROGRAM</u>, Geotechnical Design Summary Report, Volume 1.
- 3 <u>UNDERGROUND TECHNOLOGY PROGRAM</u>, Geotechnical Design Summary Report, Volume 2.
- "Petrophysical Analysis US Army Corps of Engineers Hole FK-1, Bullitt County, Kentucky", ResTech Inc., Houston Report, April 1990, Houston, Texas.
- 5 <u>Underground Technology Program, Test Adit Construction</u>, Solicitation No. DACA27-92-R-003, US Army Engineer District, Louisville, Kentucky, May, 1992.
- Rock Engineering, J.A. Franklin and M.B. Dusseault, McGraw-Hill, New York, 1989.

# Appendix A Geologic Core Logs

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RUN & 53C-54L  S3C / RUN & 53C-54L  STAY Shally 1.5.  Champing to pure  L. S. Had is light  STAY with hues of  Actuar gray color.  Whosh porcens a Vingory  Especially @ 538.7-539.2  A 542.8-543.8  With some deep vings.  @ 543.8 care gets  batter in quality—  Non porons—and it  has gray shall huses.  Recovery 10.1  Recovery 10.1  Recovery 10.1  Recovery 10.1  Recovery 10.1  Recovery 10.1  A 541.8-54.8-54.2  A 542.8-54.8-8  With some deep vings.  Champing of 546 to  I famish or pinkish gray  L. S. (with quarter)  Slightly porous & stilly.  Weathered, course grained	ELEVATION	DEFTH	receno			ERY	NO.	(Drilling tops, w weathering, etc.	wier iam, depth of if significant) e	
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained			17				•			E
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained	1 1	=	1/							F
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		=	1							E
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		Ξ	P							F
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		Ξ	11							F
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S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		_	17							Ē
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained			Γ,					•		Ε_
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		=	1-4							E
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained			77							<u> </u>
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained		-	1/1							Ė
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained	İ		17/							F
S36-536.45 light  Gray shaly L.S.  Champing to pure  L.S. that is light  Gray with hues of  Lowker gray color.  Mod. porous & Vuggs  especially @ 538.7-534.2  A 542.8-543.8  With some deep vugs.  Better in quality—  Non porous—and it  has gray shale lenses  Light gray L.S. 21 darker  gray hues a horizontal  518 gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (with quarte)  Stightly porous & stilly.  Weathored, coarse grained	,	534	11/	RUN 6 534_	. 546					E
gray shally L.S.  champing to pure  L.S. that is light  gray with hues of  darker gray color.  mod. porous & vuggy  especially @ 538.7-538.2  4 542.8-543.8  with some deep vugs.  Ø 543.8 Core gets  better in quality—  non porous—and it  has gray shale leuses  Light gray L.S. 2/ darker  gray hues a horizontal  soft gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.S. (willh quarte)  Slightly porous & shilly.  Weathered, coerse grained		_	1/1					OT : 35		- <u>F</u>
Changing to pure  L.S. that is light gray with hues of  darker gray color.  mod. porous & vuggy especially @ 538.7-538.2  4 542.8-543.8  with some deep vugs.  Ø 543.8 Core gets  better in quality— non porous—and it has gray shale lenses  Light gray L.S. 2/ darker gray hues a horizontal  521 gray shale seams.  Changing @ 548 to  tamish or pinkish gray L.S. (willh quarte)  Slightly porous & stilly.  Weathered, course grained		Ξ	7,7	gray shalu i	2.~					F
L.S. that is light  gray with hues of  darker gray color.  mod. porous & vuggy  especially @ 538.7-539.2  # 592.8-593.8  with some deep vugs.  Better in quality—  non porous—and it  has gray shale lenses  Light gray 1.S. 2/ darker  gray hues & horizontal.  318 gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quartz)  Slightly porous & shily.  weathered, coarse grained	]	Ξ	1							F
Jean with huse of  darker gray color.  mod. porous & Vuggy  especially @ 538.7-539.2  & 542.8-543.8  with some deep vugs.  Better in quality—  non porous—and it  has gray shale lenses  Light gray c.s. of darker  gray huses & horizontal  soft gray shale seams.  Champing @ 548 to  tamish or pinkish gray  L.s. (will quarte)  Slightly porous & stilly.  Weathered, coarse grained		=	7. 7					Recovery	10.1	E
darker gray color.  mod. porous & Vuggy especially @ 538.7-539.2  & 542.8-543.8  with some deep vugs.  @ 543.8 Core gets  better in quality— non porous—and it has gray shale lenses  Light gray 1.5. 2/ darker gray hues & horizontal  soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray L.S. (with quarte)  Slightly porous & stilly.  Weathard, coarse grained			7, 2		_			,		F
SHE Service & Vaggy  especially @ 538.7-539.2  # 542.8-543.8  With some deep vags.  @ 543.8 core gets  better in quality—  ron porons—and it  has gray shale lenses.  Light gray L.S. 2/ dasher  gray hues & horizontal  whe soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (will quarte)  Slightly porous & stilly.  Weathered, coarse grained			7,7,	•						E
especially @ 538.7-538.2  # 592.8-593.8  With some deep vugs.  @ 593.8 core gets  better in quality—  non porous— and it  has gray shale lenses.  Light gray L.S. 2/ dasher  gray hues a horizontal  soft gray shale seams.  Changing @ 548 to  tamnish or pinkish gray  L.S. (will quarte)  Slightly porous & stilly.  Weathared, coarse grained		Ξ	7 7	gorker Iren	color.					E
A S42.8 - 543.8  with some deep vugs.  @ 543.8 Core gets  better in quality -  non porous - and it  has gray shale lenses  Light gray L.S. of darker  gray hues a horizontal  soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			7	mod. porous	* 04222					F
with some deep rugs.  @ 593.8 Core gets  better in quality -  non porous - and it  has gray shale lenses  Light gray L.S. w/ darker  gray hues a horizontal  soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  slightly porous & stilly.  Weathered, coarse grained		=	7	especially @	538.7-53	1.2				E
Detter in quality—  non porous— and it  has gray shale lenses  Light gray L.S. 2/ darker  gray hues a horizontal  Soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			7						•	F
Detter in quality—  non porous— and it  has gray shale lenses  Light gray L.S. 2/ darker  gray hues a horizontal  Soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			77	with some a	leep vugs.					E
better in quality—  Non porous— and it  has gray shale lenses.  Light gray L.S. w/ darker  gray hues a horizontal  Soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			7/7	@ 543.8 Con	e gets					E
Ron porous - and it has gray shale lenses.  Run A 546 - 556  Light gray L.S. 2/ darker  gray hues a horizontal who is loo !.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained		=	7	better in qua	فالمر _					E
Run A 546 - 556  Run A 546 - 556  Light gray L.S. 2/ darker  gray hues a horizontal who look  soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained		-	$I_{f}I$	Non porous -	and it					E
SHE / Run A 546 - 556  Light gray L.S. 2/ darker gray hues a horizontal whe loo 1.  Soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained		=	$T_{r}T_{r}$							E
Light gray 1.5. 2/ darker  gray hues a horizontal  soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			-/-							E
Light gray 1.5. 2/ darker  gray hues a horizontal  soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained			<del>/                                    </del>							F
Light gray 1.5. 2/ darker  gray hues a horizontal  soft gray shale seams.  Champing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained	5	546	17	Run A 546	- 556					Ė
Soft gray shale seams.  Changing @ 548 to  tannish or pinkish gray  L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained		=	4,4					Recovery	10.05	E
changing @ 548 to  tannish or pinkish gray  L.S. (with quartz)  Slightly porous & stilly.  Weathered, coarse grained		3	7	draw price +	baria - b	.				=
tannish or pinkish gray L.S. (with quarte)  Slightly porous & stilly.  Weathered, coarse grained		=	/, /	- Soll gray shall	e seams	٠. ا			<b>7.</b>	E
tannish or pinkish gray L.S. (with quartz)  Slightly porous & stlly.  Weathered, coarse grained		- =	-4-,-4	Changing @ 5	49 1-		1			F
Slightly porous & stilly.  Weathered, coarse grained		Ξ	j:.1	4 2		,	ŀ			-
weathered, coarse grained		=	/	L.S L.	kish gray		1			-
- / weathered, coarse grained		=	<del>-//</del>	Slickel and	draits)		Ì			E
then character grained		크	77	meatime,	# SHIZ.					E
		∃	<del> / -</del>	Man at	use graine	7				E.
then changing again @		彐	<u> </u>	men changing	again @					E
554 back to light		_=	4, ,	254 pack to	light					E
Some Vugs : A-5 sock.		日	<del>-/-/</del> /	2102 r.s. of	at top.	1				E

MORC!			POLICE			, MEET 4
						or see
ELIVATION	DEFIN	UEGB40	. CLASSIFICATION OF MATERIALS	# COSE	SAMPLE	MINARES (Drilling sime, water last, dept.
			(Dunipina)	2017	HO.	mashering, se., if injections
	-	7 7	Complete maile			
	=	-17-1	Core breaks easily	i		
	_	7 7	upon handling at	l		
	=	<del>' , ' ,</del>	gray shale seams.	ļ		
	=	<del>  ′ /  '</del>	2 3	i		•
	-	<del>, / , ,</del>		l		
	] <del>=</del>	<b>/</b> ,-/	0/9\ ==1 =11	i		
	554	7/-/	RUN (8) 556-566			
	=	<del>'/-'/</del>	Pinkish to tamish	l		Recovery = 10
,	ΙΞ	7 7	gray L.S. , stilly. porow	}		WL = WW %
	=	77	- ·	}		50
	=	/	w dark gray hues	1		
	_	7.7	and gray shale seams			07 - 30 min.
		7	changing @ 564.5	İ		
			· ·		١ . ا	
	_		to light gray non-		İ	
	3	$I \square I$	porous L.S.			
	]					
	-	/_/	The Pinkish gray L.S.			
	=	_/	is coarser In grain			
				ĺ		
		<del>-                                    </del>	than the It. gray	1		
	_=	<del>//</del>	h.s. which is med.	ŀ		
	$\equiv$		coarse grained.		}	
	$\exists$	7	•			
		4-7-4			}	•
		11				
		_/			1	
	=	II				
	=	7.7			i	
		1, 1		ŀ		
	566	7 7	RUN (9) 566- 374			
		11				
	=	·	Pinkish to tannish			Recou. 9
	_=	//	gray List with			
	Ξ	ZZ	<u> </u>		1	water Loss =
			donker gray hues &			D.T. = 1 hr
	=	4.4	gray shale seams.	l		( - E · NT
	=	4	Umicath. & hard.	İ		
	=	4	manager of mary.			
	=	-/-	•			
	7	<del>-/-/</del>				
	7	44		-		
	7	<del>/ /</del>		1		
	<b>-</b> ]	<del>//-/</del> -				
<i>'</i>	7	4				•
		7				
	$\Xi$	7_/1	·			•
	3	17				
	_			'		
	=	<b>'</b> , 4	PUN (M) 574- 584			
	574_	_/4			<del></del>	D-T- = 110 -
	' =	77	Same L.S. us in			
į	#	乙分	previous run, with			wh = 50%
	$\exists$	$\mathcal{A}$	_			Recovers 10
[	7	4-4	soft gray shale			3
	7	<del>-/-/</del>	lenses.			
	コ					
	-1	7-7	A-6		1	

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	LOG	(Cont S	heet) REVATION TOP OF HE	_	Hole No. CS-\			
MC				SHIALLATION	-			ON MALLE
		4000	CLASSIFICATION O	F MATERIALS	# COSE	BOX OR		LARES mater hous, deputs of
PVATION	DEPTH	(ECB40	(Duriphi		ERY	NO.	woodering, at	i., if significant)
	•	/ /	<u>d</u>		+			<u> </u>
	=	<del>//-/</del>						
	_	<del>, ', -</del>			ļ			
- 1	=	<del>////</del>			1			
	_ =	<del>'/- '/</del>			l			
- 1	_	<del></del>			l			
	=	<del>  /                                   </del>						
	_	<del>-/-/</del>				i 1		
	=	<del>, / - ,</del>			1			
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	_	4,-4	•					
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	=	<del>',</del> -	0 (		1			
Ì	594 =	<del>                                     </del>	Run (11) 584	_ 594				
ļ	=		Same L.S.	as in			DJ. = 20	min .
İ	=		previous rus	ساناله			wL = 50	7.
	=	$\mathcal{I}\mathcal{I}$	vertical fre					,
İ	= =		and two be				Recou	۹.3
l	$\exists$	_/_	Sones @ s		1			
- 1		4-4			12			
I		<del></del>	£ 593 - 59	3.6	1	l i		•
	7	7/7	where drilling	4 409				
l	7	7	grapheg.	<b>.</b>	}		* plenty	of pyrite
-	-	<del>/ / ,</del>	•				at brok	en rock
	. =	4-4	Top 2 feet.	non porons,			Zones	
- 1	一日	<del></del>	fine grained					
- 1	∃	77	Porous & br	2-11-12			* A vertica	l Pzrite
		/					Seam 6	7 587.7-
}	7	-/-	587.5 - 589	m) blewin	1		590.0	
1	3	<del></del>	of Pyrite v	elms.		1	_	
ŀ		<del>//</del>	Rest of core	is wod.				
1	7	77	potous.					
	$\equiv$	<del>,                                    </del>	.3' Hick qu	Λ.,			•	
- 1	$\exists$	<del>7 1</del>	interped @	4412 504 1 501				
	=	$\perp$		285.1 - 28C.	1			
ŀ	594	//	RUN (12) 59	14 - G0 4				
ľ	~" <u>"</u>	<i>7, 7</i> .					OT "	0
	Ξ		Light gray				0.77. = 4	
	$\Xi$	<del>-/-/</del>	L.s. ~/ p	lenky of	.		WL = 1	00 %
	7	ZZ	drows de				Recov.	9.9 '
1	7	47			'			
	$\exists$	<del>-/-/</del>	6010m2 @	ef Bre				
1	. 3	+	pottom.					
	=	/	Core has a					
	=	4						
İ	一三	-44	Pulled adar		1			
	Ξ	4/-/						
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	╡	<i>,</i>			1			
	_ =	-4-		•				
l	$\exists$	1						
ļ	Ξ	$\mathcal{L}$		A-7				
		//_						HOLE NO.

		(COM	Sheet) REVASION for or HOU				Hole No.	-5-1
OMC				PERMATEN	-			OF SHEETS
LEVATION	DOFTH	ucee	CASSIFICATION OF		# CORE	NO.	(Drilling size, on creathering, att.	NEKS parr less, depth of , if significant)
	-	15/	-		•	1		<u> </u>
	=	7	1					
	_	<del>/ , / ,</del>	!					
		1						
i	=	77						
	604	1	Run (13) 604-	609				
	- =	/, 7,	604 - 605 tax	mish gray			WL 4 100	·
	Ξ	<del></del>	Las. changing t	· darker			07.= 40	:-
ł	ㅋ	/_/	greenish gray L grained, unweat	·s., fine		I	Recovi. =	4.4
	Ξ	,					•••	
ŀ	7	/	blenta of soll	duan.		. ]		
1	₹		horis. lenses.					
	7	7	Core is nonpo	***		İ		
İ	$\exists$	$\angle \angle$				- 1		
ŀ	7	<del>/ ,</del>						•
	609 <u>T</u>	<del></del>	Run (14) 609 -	45.5				
	4	-4-4	609 - 612.5	iaut area			WL= 100	%
	7	<del>-/- </del>	L.S. , non por		1		DT = ?	
	古	4.7	mod. fine grain	~ed	į		•	,
- 1	土	44	changing to		}		Recov.	1.2
İ	$\exists z$	$\overline{}$	gray L.s. w	1912				. ,
	王	7,4	to bottom of					
İ	‡-	<del>//</del> /	10 0011000 01	Gie.				
- 1	3	7-4		ŀ				
	<u> </u>	$\mathcal{I}$						
. [	-₹	7-4						•
1	3,	Z						
	_=	-4	0 4-3 4-5	_				
6	12.2	<del>-                                    </del>		- 625-5				
	===	7	615.5 - 617	5.	•	1	Recou. 1	o´
	过	7	as in previous	run		ı	w - 100	•/•
	7	7-7	changing to sh	aly L.S.			0.7 60	i
	=	<del>7  </del>	617 - 619 (dark					
	4	<del>/                                    </del>	···· ( acre	~ 2745)			0	
CI	ع <u>ا</u>		then to greeni	sh gray			Pres. core:	·
	#		thinly laminate	a shale.			618-619.	3
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DRILLING	LOG	(Cont :	Sheet) REVATE	H TOP OF HOLE				Hole No.	c5-1
PROJECT					MOTALLATION	-			SHEET
	T					3 COST	AOX OR		OF SHEETS
BLEVATION	DEFTH	LEGEND.		PICATION OF (Dustries)	MATERIALS	RECOV.	SAMPLE NO.	(Drilling mer.	water lass, depth a Mr., if significant)
	Ь.	c		4		•	1		
	05.5		Pun (16)	625.	5- 630.5				
			652.2	- 627	dark			Recov.	
	1 3		greenis	h gray	shale		. [	WLEV	٠, مه
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•	627 =	77	970-	2 40	- Immish			Pres. com	L 1
			ľ	L.S.	40			625.5-	626.4
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CS-2 Hele No. SHEET \ DRILLING LOG . PROJECT M. SIZE AND TYPE OF MY NO WITE UTP Ft. Knox , KY 12. MANUFACTURER'S DESIGNATION OF DRILL B-61 FMSH II. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN CS-2 14. TOTAL NUMBER CORE BOXES HAME OF DRILLER Serber John IL ELEVATION GROUND WATER DIRECTION OF HOLE Dec. 16 92 TOVERTICAL | INCLINED 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 16. TOTAL CORE RECOVERY FOR SORING . DEPTH DRILLED INTO ROCK 142.4 19. SIGNATURE OF INSPECTOR
G. Alsayab 642.4 S. TOTAL DEPTH OF HOLE S CORE BOX OR RECOVERY HO. REMARKS
(Drilling time, mater less, depth of westlering, etc., if eighticend) ELEVATION DEPTH LEGEND CLASSIFICATION OF MATERIALS Hole pie drilled to soo, yealth + Cased for 95' Run (1) 500 - 505.4 Dark brown unweath Water Loss = 0 New Albany shale D.T. . ? with some gray Pres. colored banding at 500 - 500.8 top 2.5 of core. 501.3 - 502.1 Thinly Seminated, fine 503.85 - 504.85 textured. Recov. 5.3 RUN 2 505.4 - 515.5 D.T. = 65 -in. Same shale with W.L. = \$ more discontinuties. Preserved: - some vertical -507.9 - 508.55 . Frequent pyrite lenses 508.55 - 509.3 4 One Printe & L.S. 509.85 - 510.6 lens @ 505.65 - 505.9 510.6 - 511.35 514.4 - 515.15 Recov. 10-2 A-11

PROJECT

ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE.

040	100	(Cent :	Sheet) REVARION TOP OF HOLE			Hole No. CS-Z	_
				2 com	BOX OR	OF SHEETIS	_
LEVATION 4	OETH b	USGB-ED C	CLASSPICATION OF MATERIALS (Description)  d	BECOV-	SAMPLE NO.	(Drilling time, master last, depth of mastering, etc., if significant)	
	11						_
	315.52		Run (3) 515.5 - 525.5				
	1		Some Shale to			Recov. 9.95'	
.	극		519.3 Where Gore			0.T. = 35 min	
	=		changes to Vuggy,			w.L. = ø	
	日		Porous tannish gray			Preserved Core:	
.	4		L.s.			515.5 - 516.6	
	, M.3 =		At 521.5 Yock change			516-6-517-65	
ſ	"∃	44	to finer grained,			518-25-519-3	ı
1	3	<del>/ /</del>	light gray to termish				
	Ŧ	7	gray non porous L.S.	ł	ļ		ŀ
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5	5.57 1		Run (4) 525-5-535.8 Same L.S. as at			Recou. 10.25	E
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	<u>-</u>		changing to darker gray			D.T. = 30 min.	F
2.	<u>-</u>		shaly L.S. @ 527.6			ن. د = ۶۶	E
	==	1	which is unweathered,			Pres. Core	E
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	===		Some 9t2.		1	529·1 - 529·9 532·6 - 534	E
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435	27	<del>//   [</del>	Pun (5) 535.8 - 545.8				
757	= 4		Shally L.S. as above			D. T. = 30 m.n	<u>-</u>
	7		changing @ 544.3		1	w.L. = p	<u>-</u>
	=	/ 1	to porous dark gray	ļ		Recou. = 10'	<u>:</u>
	事	7	L.S. A-12				-
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PROJECT							STALLATION						5-2 40 3
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	345.8	/_/_	Run (	Z1 :	545.1	B - :	556						
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DRILLI	NG LOG	(Cont	Sheet) BUYARDH TOP OF HOL	a			Hole No.	:5-Z	
PROJECT		<del>- 1</del>		PISTALLATION	<del> </del>			SHEFT S	7
ELEVATI	ON <b>DEFIN</b>	LEGENO	CLASSIFICATION OF		% CORE RECOV- ERY	SAMPLE NO.	Drilling sees, w woodboring, ste	ARKS meer law, depth of , if significant)	
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		‡	Run (10) 586.2	_ 596.4					Ė
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	596.4	<u> </u>	Rum (11) 596.4	- 606.3	· .				
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		,		HELIARUH			Secti C	rs
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626.3		<del>- ,   β</del>	un (14) 676.3 - 6	36.3				F
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	士之	$\mathbb{Z}^{-1}$	above changing	@			w.r. = 9	Ė
	37	$\exists$	sance of 8-85	`	. ]		y	E
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1	#	7	ark gray Rimy s	mate		-   '	634.2 - 635.55	E
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	<b>=</b>	Z] u	mweath, mod. s	+401				E
(3)	士							E
	3	$\dashv$	<b>A-</b> -	16		-		F
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	LOG	(Cont S	Sheet) REVATION TOP OF HOLE	DESTALLATION			Hole No.		_
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HOR	DEFTH	LEGEND	CLASSIFICATION OF		# CORE	BOX OR	REM (Deillies Ame. or	ARKS	7
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	ا ما		/20 /2	۵٠			637.6 -	639.1	E
	18 <sup>9</sup>	<u> </u>	638 - 639.8 shale.	<i>pumy</i>					E
	l 3		shake.			ļ	Recov.	e l'	Е
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- 1	7	- 1		A-17	-	-	. •		F

Hole No. C5-3 METALLATION SHEET / DRILLING LOG OF 7 SHEETS PROJECT M. SIZE AND TYPE OF SIT PIQ willy lime U TP 2. LOCATION (Com FI. Knox , KY 12. MANUFACTURER'S DESIGNATION OF DRILL FHSM 12. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN HOLE NO. (A. C5-3 14. TOTAL NUMBER CORE BOXES HAME OF DRILLER Zohn Serber IS. ELEVATION GROUND WATER ML DATE HOLE Dec. 29 Jan. 4,93 TYPERTICAL | INCLINED. 17. ELEVATION TOP OF HOLE . THICKHESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING DEPTH DRILLED INTO ROCK 139.6 19. SIGNATURE OF INSPECTOR Alsayab 639.45 . TOTAL DEPTH OF HOLE Ghailan T COME BOX OR RECOVERY NO. REMARKS
(Drilling time, major loss, depth of meathering, ote., it eignificant) ELEVATION DEPTH LEGEND CLASSIFICATION OF MATERIALS Hole pre drilled to 499.8' & Cased down to 95' 499.8 Run (1) 499.8 - 505 Dark brown Shele D.T. :: (New Albany) س، اس، من ولا unweath, frequently Recov. 5 jointed, with Pres. Core: some pyrite lenses 502.53 - 503.15 503-15 - 503-75 Run (2) 505 - 514 Shale - Same as Recour &. &. above. DT. = 40 min w L. . y/ Pres coic: 5115.35 - 506.01 507.7 - 508.55 508:55 - 509.4 509.4 - 510.45 511.2 - 511.95 511.45 - 513·55 Run (3) 514 - 524 514 - 517.5 New Albany Recov. 10.2' shale as above changing D.T. & 90 min . at 517.5 to tannish المر يد بدان gray L.S. , porous .

HOLE NO.

ENG FORM 18 36 PREVIOUS EDITIONS ARE OSSOLETE.

OJECT		(CONT	Sheet) survision for or no.	PRIMATON			Hole No.	C5-3	
						-		OF SHEETS	
LEVATION	регін	IICD-0	CLASSIFICATION OF		MCOV.	SAMPLE	Drilling sine.	LARKS THE SEAL SERVE OF	
	b	c	4	•	ERY	HO.	producting, of	i, if squipeier) B	_
	-		At SZO Lis	. gets			Pres. Co		
	7	/,/	non porous &	-			1763.	<u>~</u> .	
ł	. =	/_/		•			515.5-	- 517.05	
- 1	3	44	L.S. has plea	r? of			] -		
- 1	=	<del>//</del> /	mixed als.						
- 1	$\exists$	11	•						
		4							
1	⇉	<i>Z_/</i> :							
- (	-	扫				Ī			
- 1	∄	72				l			
	_=	117			1				
]	- ∓	1-1				•			
- 1	3	1							
- 1	⇉	<del>/_</del>			ł	I			
5	<u> 24                                   </u>	<del>/==</del>	Run (4) 524-	534.3	1	j			
	$\Xi$		524 - 525.8				Recou. N	. 3	
	#	7	nen perons L.			1			
	违	7-1		ŀ	1		D.T. = 4	40 min	
	<b>I</b>	7-1	525.8 - 526.2	- 1	}	İ	w. L. = 4		
1	<u> </u>	1/5	mixed w/ 970	y shale	- 1		_		
	12		setting shall	م د.د.			Pres. Core		
1	<u> </u>	<del>/  </del>	Szc.z - botton	_			526.2 - 5	17-3	į
į	#			į.			528 - 65 -	529 - 82	
	=======================================	77	Fine grained,		•		531 - 5	32.5	
	+	#	and unweather	red.	j		532.5 - 5		1
ĺ		77					35-		
ł		ケ!			]				
ł	<del>-</del> Z	I							
- 1	$\exists$	11							ŀ
	4	7				- 1			ŀ
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ı	3					İ			ŀ
									E
	==	<i>±4</i>				1			þ
	<u></u>		2un (5) 534-3 -	<b>KUU.</b> 2					E
534	· 44							<del></del>	·
	3	. <del></del>	shaly L.S., So				Recou. 10	,	E
		7	above with blen	-4-4	1	1	D.T. = ?		E
	34	7 '	duents.		1		کو ہے ،یا،پ		F
	+ 5	<del>-</del> /-/ \	-5. gets less	shaly	İ		•		E
	_===	7-1	. coarser grains	- 1			Pres. Gie:		E
	35		541.5 to both			ļ-	534.3 - 53	•	F
	=	4	- 1 10 00111				36.6 - 53		E
		<del>-</del>	544 - 344.3	ie-e-k_	ľ		38-2 - 53		E
	五	ZI °	gray L.S.						F
1	$\exists Z$	7					40.3 - 541		E
ļ				1		L.	41.65 - 54	9 )	Ľ
	3.5	-7	•	ĺ	- }	5	41.63 - 57	3.6	F
	美	至				5	41.63 - 57	3·C	E

DRILLING	roe (	Cont 5	heet) REVATION TOP OF HOLE				- '3
PROJECT			PISTALLATION		-	34	FT <b>SHEE</b> ET
REVATION	DEFTH	LEGENO	CLASSIFICATION OF MATERIALS	# CORE	BOX OR SAMPLE	REMARKS (Drilling sine, water l	ou, depth
BTAVISON	) b		(Dumpun)	ERY	NO.	washiring, etc., if e	
	-	7:Z					
	₹	7-1		ļ			
	- 4	77					
	1			ļ	i i		
	1 7	14	•				
•	$\mathsf E$	11					
		Ħ.	Run (6) 544.3 - 554.6		1		
	544·3-	77				Recov. 10.3	,
	1 7	47	Light gray L.S. wit	<b>~</b>			
		//	plenty of 912, poro		1 1	0.7. = 60	~i ~
	$\exists$	7.7	to the same same same	اذ		w.L. = 15	
			unweath, with fet	160	1 1	,	
	l ‡	44	odor.	1			
	l ≓	44	Frequently jointed				
	7	<del>//</del> /	, -	- 1			
	=	1/1		1			
	-	1					
	∄	1,1					
	∣≓	4,4					
	7	<del>//</del> /					
		4			1		
	] ]	1/		1			
	🗗	7.7					
		44					
	]	1,-4			•		
	=	4	•		1		
		17					
	ゴ	1.1			1		
	ΙE	-1,-4					
	=	ケナ					
	564.4	77	Run (7) 554.6 - 364.	<u>'</u>	<b></b>		
	' '	44	crei linkl	tannish	.	Recou. 9	.a´
	l	<del>-//</del>	1 337.0 3	1		5	
	1 =	<u>//</u>	gray mostly non por			1	
	▎╡	44	L.S., frequently joi	mpeg		w.L. = 8	
	=	4,4	changing @ 555.1		4		
	-	11					
	=	1,1	to light gray slight	١	1		
	4	<del>//</del>	1 -			1	
	=	77	Frequent discontin.			1	
	] 크	1	plenty of 9tz.			İ	
	4	1,1.	559.4 - 564.4 tan	. المحنم			
	=	<del>/-//</del>	1	1		ļ ·	
	=	11	gray L.S. again.			1	
	3	1,	<b>-</b> 11 . 1			1	
	7	11	Felted odor.	1			
	=	1,1					
	=	1//				1 .	
	=	4/		ł		1	
	] =	1/					
	=	4					
	=	111					
	=	11		İ			
	] =	<del>-                                    </del>	A-21		1		
	A 1836-	1 /				1	HOLE H

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MICHING	LOG	(Cont S	Sheet) MAYAROM TOP OF HOLE			Hole No. CS-3
					BOX OF	O' SHEETS
LEVATION	DEFTH	UEGD40	CLASSPICATION OF MATERIALS (Dumpnin) d	SETY	SAMPLE MO.	(Drilling term, mater less, depth of measthering, etc., if agrificant)
	=	11				
	44.4-	4	Run (8) 564.4 - 573.75			Dec. 31,92
	,	, , , ,	Same tan gray			Recov. = 9.35
	-	1	L.S. as above			
		7.7	w/ fetted odor.			D.T. = ?
	-	-/-				w.L. = ¢
		7-7	mod. porous.			
		7.2				
- 1		//-	•			
İ		44				
	=	11				
	_ =	<del>///</del>	•			
	$\exists$	11				
	#	<del>///</del>				
ı	$\exists$	77				
1	╡	<del>///</del> /				
1	$\equiv$	7,7,				
	. 🛨	$\frac{1}{2}$				
	- 3	,7,4				
	=	7,7,	0 10 57775 597.1			•
\$	73.75	<del>///</del>	Run (9) 573.75 - 582.1			Recov. = 8.35'
İ	∄	7,7	Top .25 same han		1	
1	#	77	gray L.S. changing		Ì	0.T. s co win w.L. s ys
	3	74	to light gray fine grained unweath. L.S.	1	Ì	Q.C. 1 p
		77	-			
	_3		at 574 - 576 with	ŀ		
	===		few vuggs with gray			
-	3	7	soft shake lenses	ŀ		
		7	k bottom of that zone			
İ	$ \exists$ :	<del>//</del>	then at 576-582.1	.	Ì	
	1	4	•	1		
İ			back to tamish gray	İ		
}	_ =	54	porous, sw. L.S.			
1	<b>-</b>	<del>/</del>				
	<b>=</b>	77		Ì	ĺ	
		7	0 (0) 1 2	1		
5	82.1	<del>/</del> /	Run (10) 582·1-583·9			
	-12	//	Same tonnish gray		1	Run was cut short
	===	$\mathcal{L}$	L.S. , less porous	}		due to blockege
	<u> 국</u>	7	than before	ŀ	l	of water circuit.
	<b>_</b>			——	- 1	Meed to replace wit
	극'	583.9			1	Reco. 1.8'
-	E				.	V.co. 1.9
	7					
	$\exists$					
	寸					
	3		A-22	1		•
FORM -	836-A	(BR 1)	110-1-1801) GPO 1900 OF - \$25-063 .	-ONG		HOLE HO.

		COM 3	heet) REVARION TOP OF HOLE			Hole No.
ia			- SAIAMAN			or sweets
ATION	DEFTH	rice-co	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV- ERY	SAMPLE NO.	BEMARKS (Drilling sime, water loss, depth of weathering, stc., if segrifical)
	•	۲	4	-	1	<u> </u>
-	=					
	583.4	_	Run (11) 583.7 - 594			
	- E	-,-				Recov. 10.2'
	=	二工	Tannish gray L.S.			D.T 60 min
	=	//	Nonporous, hard,			w.L. = #
		7	unweath. w/ plenty			2,2, 2,9
		4	of quarte at			
	=	Z,Z	bottom 2 especially.			
	-	7_7	_			
	]	///	Also freq. shale			
	_	,/,	lenses.		}	
	=			1		
	=	/_/	Top . s porous.			
		$Z_{\mathcal{I}}$				
		7				
		/ /				
	=	7				
		7,				
					1	
	-	7,7				
	=					
		<del>7 / /</del>			j l	
		<i>ZZ</i>				
	594_	1/	Run (12) 594 - 604.2			
		7	Same as above			Rewv. 10.2
	=					
	_	44	Jetting sw & porous		ļ	0.T. = 30 min.
	3	77	and sittly vuggy at			w.L. = p/
	=	7,7	600.4 +0 604.2			
	=	$Z'_{i}Z_{i}$	with weak fetted			
		17	_			
	=	4	odor.			
		4-7-				
		177				
	=	17,7	•			
	=	17				
	] =	-4				
	=	$Z_{j}^{*}Z$				
	=	<b>Z</b> ,Z				·
		1	·			
	=	7	·			
	=	17				
	=	1,1				
	-	17		1	ŀ	
	=	17				
	C=41.2	77	Run (13) 604.2-614.3	<u> </u>		
-	=	4,7	Same as above.	}		Recov. 10.1
	] =	1,7	bosons to elo-3	}		D.T. = 30 min
	=	//	then less weath 4			m.r. = 4
	=	77	non porous to	1	1	
	=	7,7	end of com-			
	1 3	7	A-23			I

	11	CLASSIPICATION OF		% CORE	SOX OR SAMPLE NO.	BEMARKS (Drilling ame, mean less, meastering, etc., if agen)  E	SHETS  depth of frame)
				RECOV.	NO.	BEMARKS (Drilling sime, water lea, washering, etc., if agen	dopeb of fisant)
		4		e		E	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
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NAME OF THE PROPERTY OF THE PAR	11						
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当	11		_				,
4	1/.	n (14) 614.	3 - 616			· · · · · · · · · · · · · · · · · · ·	
	777 <b>T</b> .	nner battel	ton Lik			Recov. 1.7'	
<b>3</b>	771	atch a had					
丑红	7 77	etreived.	· - <del>-</del>				
. #	7		<b>674</b>				
	<i>, ,</i> ,	haly dark					
3/2	- / 11	S. , Pore					
13	<b>Z</b> \$	shale lense	<b>s</b> .				
3	II. o	n (15) 616.	- 626-1				
+						Recov- 10.1	
76		ark gray me				D-T- = ?	j
-]7	<i>-</i> / _1	uly L.s.	_		}		ı
12	₩ PO	unish gray	, 5147.			w. L. = ø	·
#	Po	rrous at 6	21 - 625.3		ł		1
#	₩ N	en non por	ons to				-
<i>于</i>	7 - 71	as of core.					į
7							
	7-7						I
日.2	7.		•		İ		· ·
4/;;	Z-/-						ŀ
马台	74-						ļ
=======================================					. }		
也							F
12	<del></del>				1		
1	4		,				<b>!</b>
至	ربع 🗠	n (16) CZ6.1	- 636.3				<del></del> [
<u>-}</u>		26.1 - 628.5	greenish			w.L. = 90	ł
# -	/ 1	ray Liny s	_			D.T ?	
						Recov. = 10.2	F
17	-,- G	etting bure	Snare		1	_	
: 3/2	<u></u>	E 628.5 - 6	35.1			Pres. core !	į į
	4	35.1 - 636.3	ling			627.8 - 629.2	F
4						629.2-630.72	- E
=	-   •	7	•		j	631.55 - 632.	.5
					j	634 - 635-15	
	]	•			-	635.15 - 636.	·3 [
			A-24		1		
_			Getting pure  Le 628.5 - 6  635.1 - 636.3  Shale again	Getting pure shale  at 628.5 - 635.1  635.1 - 636.3 Limy  shale again  A-24	Getting pure shale  at 628-5 - 635.1  635.1 - 636.3 limy  Shale again	Getting pure shale  at 628.5 - 635.1	Getting pure shale  at 628.5 - 635.1  Fres. cove1  627.8 - 629.2  629.2 - 630.73  631.55 - 632.  634 - 635.15  A-24

DRILLI	40 TOG	(Cent :	Sheet) REVANON 1				Hole No.	
PROJECT				DISTALLATION	-			OF SHETTS
<b> </b>		T	77.444	ATION OF MATERIALS	% CORE	SOX OR		FMARES
BLEVATIC	N DEFTH	(ECD4D	CASSIFIC	ATION OF MATERIALS (Description)	RECOV-	SOX OR SAMPLE NO.	(Drilling since	, water last, depth of etc., if significant)
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•		j			İ			
	-	<del> </del>		•				
1					1			
	636.3	1	Pun (17)	636.3 - 639.45	İ			
l	P30. J		~~~		+	<del></del>		
j	-	144	Dork a	reenish gray	1	[. ]	. 6	
l	=	1-	Det - 2	1, , 1	1		Pres. C	946 ;
į.	] =	1 <del>,/,/</del>	shale (	limy) at		1 1		∠2X.\
ļ	=	1//			1		636.3.	30-/
i	] =	<del>  / / /</del>		grading to	1			
	=	<del>  / /</del>		S. & to	1			
ŀ	1 =	125						
1		-/ /	tannish	3 ray 2.5.	1			
. Ì	639.4	]						
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Hole Ne. CS-4 MEET \ MISTALLATION OF 7 SHEETS DRILLING LOG M. MIZE AND TYPE OF SIT NO WITE PROJECT **YTP** LOCATION (C. 12. MANUFACTURER'S DESIGNATION OF ORILL B-CFI. KNOX , KY DRILLING AGENC FMSH UNDISTURBED 13. TOTAL NO. OF OVER-HOLE NO. (A. C5-4 IL TOTAL HUMBER CORE BOXES HAME OF DRILLER Zohn Serber IS. ELEVATION GROUND WATER DIRECTION OF HOLE M. DATE HOLE Dec. 16,92 DEG. FROM YERT DVERTICAL | INCLINED 17. ELEVATION TOP OF HOLE THICKNESS OF OVERBURDEN 16. TOTAL CORE RECOVERY FOR BORING 144.65 DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR Alsageb 643-85 S. TOTAL DEPTH OF HOLE REMARKS
no, custor loos, depth of
d, oto., it significant CLASSIFICATION OF MATERIALS ELEVATION DEPTH LEGEND Hole pre dilled to 499.2' & cased to 95' 2epth RUN (1) 499.2-505.3 Recov. Dank brown New Albam D.T. = 35 min shale with gray w. L. = 100 % hues . Two soft gray clay Pres. Core : Zones @ 499.4 - 499.5 301.45 - 502·Z 502.2 - 503.05 and 499.6-499.9 503.8 - 504.6 Run (2) 505.3 - 515.3 505.3 Recov. 10 New Albany shale w/ pyrite lenses 4 W.L. = 50 % D.T. = 60 min 1° thick pyrite interbed ( 506.6 Started loosing water at 510 depth . Pres. core : 507.5 - 508.45 509.4 - 510.3 511.15 - 512.4 SIZ.7 - 513.3 514.1 - 514.7 **A-27** 

	LOG	(Cent !	Sheet) SEVATION TOP OF HOLE	TALL ASSESSED.			Hole No. C5-4	
DARCT				IAMARON			O. Helis Belli S	
LEVATION	DEFTH	ucavo	GASSIFICATION OF MA	TERIALS	% CORE	BOX OR	BENARKS (Drilling time, water less, depok of	
_	<b>b</b>		(Omipile)		847	HO.	emedicing, etc., if significant)	
	<u> </u>	•			-		•	
	1 2		0 4. 4.4					
	515.3		Run (3) 5/5.3 -	945.3				-{
	l 3		515-3 - 520				Recov. 9.9'	ł
	] =		New Albany 5	hale.				1
	1 =		Dork brown ,				Pres. con:	I
	E		laminated, uni				516.23-517.45	E
	I. 3		with pyrife to				518.3 - 518.9	
	#	- —	<del>-</del>				518.9 - 519.8	ļ
			520 - 525.3 :				519.8-520.8	ŀ
	=		light gray , un		ł		3	E
	· -∃	— ┥	with fetted o	<b>404</b> .			0.T. = 40 min	-
	520		L.S. is perous	. @	]		0.1. 2 70	ŀ
		LJ	520-522 .		·	- 1	w.L. = 100 %	F
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	===			ŀ		1		þ
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1	E		_		- 1			E
5	25.3-	/_/	RUN (4) 525.3 - 5	35.5				+
	∃_	44	525.3 - 527.9	light			Pres. wie:	E
- 1	王	44	gray L.s. , non			ļ		E
	4	, ,	mod. coarse grad			İ	530.55 - 531.4	þ
	7	/ / [	changing to dos	ł	İ		532.8 - 534.6	F
	∃.,	/	, –	1		- 1	534.6 - 535.5	E
i		///	shaly L.s., un	, ,				E
j	7		mod. hard, to	poppor		1		þ
1	· +		of core.	İ	1			F
	<b>→</b>	1				İ	0-T. = 30 min	E
- 1	=72	//						E
		7		j			m.r. = 100 %	E
		1-1		1		- 1	,	þ
	_=-	7/				.	Recovery = 10.2	F
	3	7.1		İ		1		F
	∃7	<del>71</del>						E
- 1	7	71						F
	#/	7		ľ				F
	-∄`	7				.		Ė
	37	7						E
	4					-		F
.	<b>47</b>	27		ł				F
	7ور	V/ 0	UN (5) 535-5-5	45.5	1			E
<b>5</b> 3	<del>د.ع]</del> _	7//				-	<u> </u>	E
	37	7	Same Lis. as	1			0.T. = 50 -in	E
ł	= 7	$\angle$	bottom of las	t Yun,			w.L. = 10= %	F
-	7		shaly.				Page 15	F
	$\exists \mathbb{Z}$		7				Recours to	F
	∃./		•				•	F
	77			A-28				F

**A** 

	OJECT		r		DETAILATION	2 000	eox cel	OF BEMARKS	\$4000		
-	NOTAVEL	DEPTH	utono	CASSIFICATION OF (Description of description of description descri		BECOV.	BOX OR SAMPLE MO. f	(Drilling sime, water lan. weathering, etc., if ugain	depth of facest)		
		-	11								
		_=	4					Pres. core:		<u>.</u>	
	1	Ξ	11					535.65-537.			
	ļ		1.1					531.05 - 535		-	
.			7.7.					538 - 539.2			
			1//					542-9 - 54	• • •	=	
]		-	111		• .						•
		11	$Z_{\mathcal{I}}$		•			•			
1			1/2/								
1			11/								
l			///				1				
		<sub>545.5</sub> -	$\mathbb{Z}$	0(1) 8455	EEE.T					1.1.1	
İ	ľ	٠,٠٠٠	1/1	RUN (6) 545.5-				Recov. 10.2	,		
ľ			1	Top foot gray				D.T. 20	\		
	1		1,1	It. gray pore				w.L. = 100 %			
		Ξ	///	with felled					•	<u> </u>	
		=	7	Vuggg & 5111	. weath.	1		Pres. core:			
		_		More Unggy @	_	Ĺ					٠
			44	11945 07722 G				545.5 - 54	יי		
		Ξ	<del>/_</del> /								
			4							E	
	1		1			İ				<u> </u>	
			Z							<u> </u>	
										Ė	
ŀ		Ξ	<del>  /- /  </del>							<u> </u>	
		Ξ	77			ł				E	
		_=	7.7		•	,					•
·		=	4						• •	-	
		=	4	•							
		=	1							Ē	
		555-7	-/-	Run (7) 555.1	- 565.8					<u> </u>	
			7-	555.7- 557	انولط عرص			Recou 10-1		=	
		_		busons ' na 392	L.S.			D.T. # 20		E	
		_		with felled .				W. L. = 100	٧.	<u> </u>	
			1	more shaly a porous - w	v ot ees! 	****	1			E	
		_	Z,	gray color 5					•	<u>F</u>	
ŀ	<i>'</i>	Ξ	<del>// /</del> /							=	
l		_	17-7	At see Lis.		1		•		F	
1		=	ŹŹ	sitly weath,		1				E	
		=	1,1	gray & poron					•	E.	
		=	<b>//</b> /	strong odor.						F	
1		=	7/			1				E	
		_	/_/		A-29					<u>E</u>	
BN	G FORM	1836-	-A (ER	1110-1-1801) epo 1900	07 - 429 - 663	MORCI			DLE 140.		

MIC DAY	- 100	(Cont	Sheet) REVATION TOP OF HOLE			Hole No. C5-4
			PETALLARDR			or seems
EVATION	DEFTH	uco-co	CASSIFICATION OF MATERIALS	SECOV-	BOX OR SAMPLE MO.	EMARKS (Drilling sime, water fee, depth of masthering, ste., if significant)
	<b>b</b>	٠, د		-		
	=	/, /				
	∃	,-,-	·			
		7/				
	=	77				•
	=	77				
	]	7				
•	565.8	$\mathcal{L}$	Run(8) 565.8- 576			
		4-1	565-8 _ \$67.4 Portous			0.T. = 5
	▎∃	4	tamish gray L.S.,			•.
	l ∃	7/7	sw, getting unweath.			W.L. = 100 %
	=	<del>/-/</del> /	to 570-3 than sw			Recov. 10.2
	7	<del>'///</del>	again to bottom of core			
	E	77	· .		·	
	ⅎ	77	Ogosoms.			
		7				
	日	$\angle Z$	·	Ī		
	Ξ	III				
	=	_/_/	.	į		
	7	<del>,/_</del>		j		
j		<del>// /</del> ]		]		
- 1	=	<del>/ / /</del>				
İ		77			j	•
1	E	77		l	İ	
1	王	$\mathcal{I}$				
- 1	#	4	·	ŀ		
1	£	<del>/  </del>		1	1	
	7	-/-1		1	ŀ	•
	=======================================		·			
	576	/	Run (9) 576-586			
ĺ	` ‡.	<del>/_</del> 4	Top . 6' harmish gray			D.T. = 20 min.
I	⇉	<del>//</del>	porous L.S., SW,		ļ	W.L 100 %
1	<b></b>	<del>///</del> /	•	İ		With a top 75
1	==		delting darker gray,	ļ		Recov. 10
.	====		shaly a mod. carse		l	
- 1	<u>-</u>	<del>-/</del>	grained 576-5 - 578-7			
	#:	<del>-                                    </del>	where It has I' thick			
1	===1'		shale bed @ 578.7	Ì	l	
i	$\Xi$	/	and 576.5 (both	1	-	
			ends of thet shady zone	,	1	
1	3/	<del></del>				•
	34	, , ,	than back to tamish			
	4	<del>, / ,  </del>	gray perous L.S.			w Name to the
	_#/		1			where have no been
1	王	$\mathcal{L}$	.			where hung up bet
	∃Z					not pe money no
	+	4				or down.
1	=	_/_	ļ			Flushed hole by
- 1		44				inserting water hose
	₫,		. 1			all way down, used
	<u>, 4</u>	74	2.00			Soap & bentonite,
15	es ±		A-30			
1	-		<b>i</b>		1	

PORT		(cont 3	heet) BEVARION TOP OF HOLE			Hole No. C5-4	
PROJECT					<del></del> .	OF SHEETIS	
REVATION	DEFIN	uice o	CLASSIFICATION OF MATERIALS (Description)	# CORE	BOX OR SAMPLE HO. f	REMARKS (Drilling since, water less, depth of measthering, ste, if significant)  E	
	-						F
	584 -	[	Run (10) 586 - 596.2			Dec 21, 92	F
	205	7-7	gray to tamish gray			stuck on wood.	E
	Ξ	7	L.S. with leases of	1		Freed on Fri	F
		77	soft gray shall .			Resumed coring on	F
	=	/_/	Non porous, unworth.			Hon. Drc. 21, 92	E
		-/-/	with dwarts.			Using Revert mud.	-
	=	7				432	E
		7	Smooth texture.			D.T. = 45 min.	
	=	1, 7				W.L. = 100 %	E
		1-/					
	=		•			Recov. 10.2	E
		77				•	
		$\mathcal{L}$	•				E
		/4					F
		4					
		17					
		/					Ε.
		44				•	<u> </u>
	=	4					=
		7					
	1	$\angle$				•	=
	596.2	-/-/	Run (11) 596-2 - 606-4				
		4	596.2 - 602.5 Same			D.T. = 50 min.	=
	$\exists$	4	Lis. as above, smooth			W.L. = 100 %	
	=	4	textured.				F
	$\exists$	77	At 602.5 core gets			Recov. 9.95 on 10.2 Tun	
	11	/_/	tannish gray . Rock			(6.2 144	Ė
		' '	gets vuggy @ 603.5-			•	
	=	-/-/4	605 4 porous 605_				<b> </b>
	=	7	pottom.				
·	Ξ					•	Ė
	ヸ	11	2 broken rock zones			•	<u> </u>
	=======================================	<del>[                                    </del>	where rod bropped				E
	=	<del>//</del>	while coring at				<u>-</u>
	$\exists$	77	604.8 - 605 4				E
	Ξ	4.7	•				<u> </u>
	크	44	605.3 - 605.5				E
	三	7:-	where vuggs caused				<u> </u>
	=	7-4	rock to break.				Ė
	Ξ	$\mathcal{T}'$					E
,	7						ŧ.
	_=	$\bot \angle \angle$					E
	606-4	//					E
	<b>~</b> 3						<b>=</b>
	=					, ,	E
	Ξ					, 	E
	극						<u> </u>
	Ξ		A-31	•			E
NG FORM	لتجييب			PROJECT	<u> </u>	HOLE HO.	L

DAC	<del>-</del>	,	Sheet) BEYARDH TOP OF HOLE			Hole No. CS-4
SEVATION	регтн	1100-0	CLASSIFICATION OF MATERIALS	BECOV.	BOX OR SAMPLE NO.	CF DISTS  REMARKS (Drilling time, water last, depth of westering, str., if aquifases)
-	-	٠		•	-	
	66.4		Run (IZ) LOL-4- CIL-T			
.		I,I	Light tamish gray			D.T. = 50 min
	- 3	1/1	L.S., wealth.,			w.L. = 100 %
	$\equiv$	1	bosons & nadda mith			Recov. 10.2
	크		fetted odor.			Keenu.
-	=	7/	Changing color @ 614			
	크	7 /	to cement gray , more		l	
	₹	<del>,                                    </del>	porous à conver graine	١.	ļ	
	目	T / I	Deteriorated rock			
		$\mathcal{I}$	Zone @ 612.6-612.8			
	7	<del>- ,                                   </del>		- 1		
	4					
	. 🗦	<del>,/,</del>				
.	<u>-</u>	7		1		
	₫.	7,7				•
	3	<del>/  </del>		1		
	₹/			İ		
	4	<del>//  </del>				
اع	تي.ن	7,4	Run (13) 616.7-626.85			
	∄	<del>-/-/</del>	616.7 - 624.3 Same			Recov. 10-2
	<u>-</u>	, ,	L.s. as at bottom of			w.L. = 100 %
Ì	₫-	777	previous run (coment		!	D.T. = '35 min
	=	<del>// /</del>	gray , perous )			
	=======================================	II	629.3 - bottom : gets		1	
	Ξ,	//	shally , with them	ļ		
1	土	<del>/-4</del> .	gray L.S.		ł	
	工	77	- 0			
	<u></u>	44	plenty of gray shale	1		
	$\exists z$		lenses.		[	
		<del>/ /</del> /		ĺ		
	#7	7			.	
	7					·
	4	<i>7</i> .Z				Ì
	4-			ľ		
	#	$Z_{\mu}$		ł		İ
	<u> </u>	<del>- /</del>				
CZ	.25	771	Pun (14) 626-85 - 636-85	<u>·  </u>		
	立	<del>/ /</del> /	626.85-650 tamish			D.T. = 95 min
	-37,		gray, non parous Lis.			w.L. = 100 %
	===		beaging to garker deat		1.	Recou. a.a'
	<b>事</b>	<b>∠</b> ;	shally 6.5. to 632			
		74	A-32			
ORM 18	36-A	(BR 111	(0-1-1801) GPO 1900 GF - 620-003	OJACT		HOLE HO.

DRILLING	LOG	(Cent S	heet) ALVATION TOP OF HOL	PISTALIATION			Hole No. CS -4	T PIETTS	
REVATION	регти	u(GB+0)	CLASSIFICATION OF			BOX OR BAMPLE MO. f	REMARKS (Drilling sime, master less, demostering, etc., if regulfs		
<u>                                     </u>	-	1//	Then grades	\• <b>*</b>	-	-		=======================================	
	=	4	Diceminy Dia				Pres. Core:	<u>E</u>	
	=	<del>,</del>	(waldron),					E	
	632	7	laminated &					E	
			textured to					F	
			of core (i.e					F	
	] =	├	632 where	inale				E	
			starts )					E	•
								E	
	I							F	
	三				.			臣	
		— —						E	
_	(36.85		Run (15) 636.					<u> </u>	
	=		shale (wald				Recov. = 7 '	Ę	
	=====================================		as in botton				w. L. = 100 %	. ⊨	
	=	-==	previous run	• •			0.7.	E	
ļ	=		to tannish				<del>-</del>	E	
	]		L.S. at 6	41.5			Pres. core:	<u>E</u>	
			639 - 640.5	shale 4				F	
	」当		L.s. mix.	·				E	
	64.5	<del>-</del>				•		E	
	1	24				1		E	
	╡	ZZ					•	F	
	-	11						F	•
	43.85	<del>/ /</del>	Вон	•				F	
	[ ]	<del></del>						·E	
	]	1						<u>E</u>	
	=		• .					F	
	円							E	
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	=		•	A 22				E	
ENG FORM			110-1-1801) app 1988	A-33	PROJECT		HOLE	<u></u>	
	1830-	P ' '	SPO 1900	OF - 629 - 663					

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DU	ادون	73 3 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		_	rume			•	••••	70111 Z
Project Detect	!	117 P 5 119 1 9 3 Complete -6 18 1 9 3			lace um fi				_	
Locatic Drilling Driller _ Drill N Thickne Depth . Total D	On N. Age Type Type Metho ess ( Drille Depth	Resident Heller E Ft. Keek, Ky may Boyler Bress Still Inspector Lerses: Failing Hole Mester CF-13 d 17 1/17, 17 11 117, 2 11 117 d into Rock 609, 7' of Boring 645.3' ng X Vert Inclined Deg	JSCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	LE NUMBER	LE TYPE	TURE CONTENT (%)	INDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
ELEV.		SOIL CLASSIFICATION	180	Ş	5	AMP	AMP	1018	5	
701,112	DEPTH	SURFACE COVER		-	-	8	8		9	
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2	Brown, <u>CLAYEYSILT</u> , Moist, Soft to Madium Stiff (0'-3')	mL							9 1/4 " Triconc Roller  Bit to a depth of  49.5'  Installed 6 " Sch 80 -  P. V. C., to a depth of
296./2	<i>y</i> 111	11120 mm 3 7777 (3-51)	CH					-		47ft, The cosing  Fell 205 when started  to use 434 "Hammer  Prill. Glund an
اديداديدا	77111	Red to Roddish Brown, Cherty <u>CLA</u> , Domp to Ory, Mod Stiff to Medium Stiff (5'-24.8')	CH							extension on to P.K.C.  Casing  Ouptn of 6"P.Y.C.  Casing 49.5' m/  1'Stickup
مديا المديا المدي	المساليسانين								1	24" Corc
	7 7			+					2	Conc Borrel  Asing a surface set  25/CT  N 35 Ø 38 649
- /.										Type @ 2 Ø 406676
- 1	ستأسأتسأ									استطيعتهامتنه
YMBOLS:	<u>₹</u>	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	I ETIC				_	L	\	PARTIAL LOSS OF DRILL FLUID

SHEET \_/ OF 33 . A-35

Determined for Surface E.  Dotting Agency Drill Method. Thickness of Overburden. Determined into Rock. Total Depth of Boring. Dr. of Boring.	Project	<u>(5-5-</u>					Installed
Doubling Agency Driller Drilling Agency Drill Type Drill Method Drill Type Drill Method Depth Drilled into Rock Total Book of Boring Dr. of Boring Unit SURFACE COVER  ELEN. E SOL CLASSIFICATION EPUL 22  24  25  27  27  27  27  27  27  27  27  27	Date:Start/ Comple	te/_/	_				
DOWN INSPECTOR INSPECTOR DOWN THE PROPERTY OF	Location NE		Ť	7	ĪĨ	_	
DIT Method:  DIT Method:  Thickness of Overburden.  Thickness of Overburden.  Total Depth of Boring.  Dit of B	Drilling Agency		ļ	-   "			8
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20	Driller inspector		Z I	- 1		₹	
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20	Drill Type		Ĕ   :	=	11		I ARODATODY DESIGNED
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20			5	2   2	5		L
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20				₹   Ş			77 l
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20			AS I	5   ≥			<u> </u>
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20		rolland Doc	정   6		백백		<b>j</b> i .
SURFACE COVER  27  27  27  28  29  20  20  21  21  22  22  23  24  25  26  27  28  28  29  29  20  20  20  20  20  20  20  20			8 3	8 8	들들	5	
22- 23- 24- 24- 24- 24- 24- 24- 25- 26- 27- 28- 28- 29- 29- 29- 29- 29- 29- 29- 29- 29- 29	SOIL CLASS	SIFICATION	5   2		8 8	13 8	
22 22 23 Light Red, Film SAMPICLAY  24 W/Leases of CLATET FinSAMS CL/  25 Med Stiff  (24.8' - 35.8')  27 Med Stiff  (24.8' - 35.8')  28 29 29 29 29 29 29 29 29 29 29 29 29 29		E COVER					
22- 24- 25 Light Red, Eine SAMPY CLAY 24 W/ Leave of (LATEY FireSAMP) CL/ 25 Damp to Minist Siff to 27 Med Stiff  (24.8' - 35.8')  28  29  30- 31- 31- 32- 31- 31- 32- 31- 31- 31- 31- 31- 31- 31- 31- 31- 31	E 124				T	П	
22- 24- 25 Light Red, Eine SAMPY CLAY 24 W/ Leave of (LATEY FireSAMP) CL/ 25 Damp to Minist Siff to 27 Med Stiff  (24.8' - 35.8')  28  29  30- 31- 31- 32- 31- 31- 32- 31- 31- 31- 31- 31- 31- 31- 31- 31- 31	E 1,,1					11	
27  27  28  29  20  21  21  22  24  25  26  27  28  29  29  29  20  20  20  20  20  20  20	E 143	• 1	1			1 1	-
27  27  28  29  20  21  21  22  24  25  26  27  28  29  29  29  20  20  20  20  20  20  20	E   ] .	į	- 1				
Top of Rock  24  25  26  27  26  27  28  29  20  20  20  20  20  20  20  20  20	<u> </u>	1	- 1	1 1			
Top of Rock  24  25  26  27  26  27  28  29  20  20  20  20  20  20  20  20  20	E 1 3	1		1			Ī
Top of Rock  24  25  26  27  26  27  28  29  20  20  20  20  20  20  20  20  20	£ [27]		]	1 1		ı	
Light Red, Fine SAMOP CLAT  4/ Lraces of (LATE) FineSAMO CL/  Domp to Moist Suft to  12 Med Stiff  (24.8'-35.8')  14  Tap of Rock  Tap of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  Musthered, Damp on/ CLAT  SEAMY  (35.6 to 62')  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY	£ [7]	ļ					-
Light Red, Fine SAMOP CLAT  4/ Lraces of (LATE) FineSAMO CL/  Domp to Moist Suft to  12 Med Stiff  (24.8'-35.8')  14  Tap of Rock  Tap of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  Musthered, Damp on/ CLAT  SEAMY  (35.6 to 62')  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY	<b>t</b> [ ]			1 1			
Light Red, Fine SAMOP CLAT  4/ Lraces of (LATE) FineSAMO CL/  Domp to Moist Suft to  12 Med Stiff  (24.8'-35.8')  14  Tap of Rock  Tap of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  Musthered, Damp on/ CLAT  SEAMY  (35.6 to 62')  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY  WATER LEVEL AT COMPLETION  OPPORTUNITY	<b>├ १७</b>		- 1		11		
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Top of Rock  Top o	E PI- Med STIFF	1			11		1
Top of Rock  Top o	[ ] (24.8'-35.8	(1)				11	7
Tep of Rock  Tep of Rock  SHALE, Light Brown to Lt Gray, Soft to Mod. Hood,  Watered, Damp of CLAY  Seams  (35A to 62')  WATER LEVEL AT COMPLETION WATER LEVEL — HOURS AFTER COMPLETION >>- PARTIAL LOSS OF DRILL FLUID >>- TOTAL LOSS OF DRILL FLUID >>- TOTAL LOSS OF DRILL FLUID >>- TOTAL LOSS OF DRILL FLUID >>- TOTAL LOSS OF DRILL FLUID >>- TOTAL LOSS OF DRILL FLUID		′	1		11	11	7
Top of Rock  31  32  33  34  SHALE, Light Brown to Lt Groy, Soft to Mod Hond, Wasthered, Damp on CLAY  SEAM,  35  Wasthered, Damp on CLAY  Seam,  35  Wasthered Tompletion  YMBOLS: Water Level at completion HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F 1-3		- 1 - 1	j	П	$\prod$	·
Top of Rock  31  32  33  34  SHALE, Light Brown to Lt Groy, Soft to Mod Hond, Wasthered, Damp on CLAY  SEAM,  35  Wasthered, Damp on CLAY  Seam,  35  Wasthered Tompletion  YMBOLS: Water Level at completion HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F 1‡		-1-1	ı	Ш	11	E
Top of Rock  31  32  33  34  SHALE, Light Brown to Lt Groy, Soft to Mod Hond, Wasthered, Damp on CLAY  SEAM,  35  Wasthered, Damp on CLAY  Seam,  35  Wasthered Tompletion  YMBOLS: Water Level at completion HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F  297	1			$14^{\circ}$		E
Top of Rock  31  32  33  34  SHALE, Light Brown to Lt Groy, Soft to Mod Hond, Wasthered, Damp on CLAY  SEAM,  35  Wasthered, Damp on CLAY  Seam,  35  Wasthered Tompletion  YMBOLS: Water Level at completion HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F   4	1	11	j			. 3
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Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	E 1"3	,	1 1	- 1		II	4
Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID						Ш	1
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Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	127-	ļ	1 1				7
Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	£   " d		1 1	- 1 1		11	$-\frac{1}{2}$
Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F 1.,,\$						3
Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	F 1''						<u> </u>
Top of Rock  SHALE, Light Brown to  Lt Gray, Soft to Mod. Hond,  New thered, Domp of CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	E   4					1	3
Top of Rock  SHALE, Light Brown to  Lt Groy, Soft to Mod Hond,  Numethered, Domp on CLAY  Seams  (358 to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	[-   15 <del>-</del> ]	$T^{\prime}$		-11		14	rater calant 1 +
SHALE, Light Broad to  Lt Grey, Soft to Mod Hord,  Numbersd, Domp of CLAY  Stang  (35st to 62')  WHER LEVEL AT COMPLETION  WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  >- PARTIAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID  >- TOTAL LOSS OF DRILL FLUID	Eccard 3 -	1				1 "	to a f Park
YMBOLS: V WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLETION >- PARTIAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID	36 Jopet Rock			1.1		1 7	VFF NOCE
YMBOLS: V WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLETION >- PARTIAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID	E SHALE, Lighter	ora to		11	11	1	4
YMBOLS: V WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLETION >- PARTIAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID	Lt Grave Soft to	Mod. Horde					4
YMBOLS: V WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLETION >- PARTIAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID	F 177 Menthoned D	-10120					4
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YMBOLS: V WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLETION >- PARTIAL LOSS OF DRILL FLUID SIL FORM 1202  > TOTAL LOSS OF DRILL FLUID >> TOTAL LOSS OF DRILL FLUID	F 7-1 ******	į l				1	3
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YMBOLS:   WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  PARTIAL LOSS OF DRILL FLUID  >> TOTAL LOSS OF DRILL FLUID  >> TOTAL LOSS OF DRILL FLUID						1	3
YMBOLS:   WATER LEVEL AT COMPLETION  WATER LEVEL HOURS AFTER COMPLETION  PARTIAL LOSS OF DRILL FLUID  >> TOTAL LOSS OF DRILL FLUID  >> TOTAL LOSS OF DRILL FLUID	JULE Providence	Shale					
WATER LEVEL HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID					11		3
WATER LEVEL HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID	SYMBOLS: V WATER LEVEL AT COMP			$\perp \perp$			
RL FORM 1202 >> - TOTAL LOSS OF DRILL FLUID	WATER LEVEL HOU	ETION AS AFTER COMPLET	ON			>-1	PARTIAL LOSS OF DRILL FLUID
	RL FORM 1202			<b>P</b>	_		

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YMBOL	s: \	WATER LEVEL AT COMPLETION	•						<del>-</del>	- PARTIAL LOSS OF DRILL FLUID

SHEET 7 OF 33 A-37

BORING NO. <u>(5-5</u>

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MBOL	s: 🔽	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COM	401 ET	TON.						- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID

SHEET 4 OF 33 SHEE A-38

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YMBOLS		WATER LEVEL AT COMPLETION						┸	Ť	- PARTIAL LOSS OF DRILL FLUID
·	. <b>*</b>	WATER LEVEL HOURS AFTER COI	/PLET	ON					, >>	- TOTAL LOSS OF DRILL FLUID

SHEET 5 OF 33 S A-39

BORING NO. <u>25-5</u>

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SHEET 6 OF 33 SH A-40

BORING NO. CS-5

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SHEET 7 OF 33 . A-41

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SHEET 5 OF 33 SI A-42

BORING NO. \_65-5

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SHEET 9 OF 33 S A-43

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SHEET 10 OF 33 SH A-44

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SHEET // OF 33 : A-45

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SHEET 12 OF 37 SHI A-46

BORING NO. <u>cs-s</u>

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BOLS: WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLUID	<u> </u>						┸	L	

SHEET \_/2 OF 33 : A-47

BORING NO. \_\_\_\_\_\_\_

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SHEET 4 OF 33 St A-48

BORING NO. <u>CS-S</u>

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SHEET /5 OF 33 S. A-49

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SHEET 16 OF 37 St. A-50

>> - TOTAL LOSS OF DRILL FLUID
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SHEET 17 OF 33 A-51

BORING NO. 25-5

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SHEET /F OF 33 St A-52

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SHEET 19 OF 33 S. A-53

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SHEET 20 OF 33 SH A-54

BORING NO. (5-5

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SHEET 22 OF 33 SH\_A-56

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SHEET 23 OF 33 A-57

>>- TOTAL LOSS OF DRILL FLUID

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SHEET 24 OF 33 s A-58

>> - TOTAL LOSS OF DRILL FLUID

BORING NO. \_5-5

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SH 1800  Start of Z# Core  Start of Z# Core  B   Policy   Park   Proceeding   Park   Proceduration    Start of Z# Core  Start of Z# Core  B   Run    Cored 9.8°  Read 9.8°  Loss 0.0°  Time   16:30 - 17:00  Warred Depth   Sample   1 48.5 2 48.74 2 78.9.9 2 48.74 2 78.9.9 2 48.74 2 78.9.9 2 48.74 2 78.9.9 2 48.74 2 78.9.9 2 48.74 2 78.9.9 2 79.9.9 2 79.9 2 7		cu - cl - l.	Н		Н	┝		_	<del>                                     </del>	SURFACE COVER		221/2
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Start of 24" (ore  Start of 24" (ore  Start of 24" (ore  By 22 Good 46"  Run 1  Cord 46"  Run 2  Cord 46"  Loss 0.0"  Time  16:30 - 17:00  Wared Orpth  Sample  Mother Return 1  Run 1 to Run 6  Run 1 to Run 6  Run 2  Cord 30"  Run 2  Cord 10.3  Rec 10.3  Loss 0.0  Time  142 Fire CLAY  Mater Loss at the  Shale Clay  Mater Loss at the  Shale Clay  Thirdy Laminated Soft to  Motion Carpet 10.3  Rec 10.3  Loss 0.0  Time  9:20 - 10:00  Wased Depth  Sample  142 Repte Lances and  Ryrite nodules.  142 Agric Loss 2  146.3 2  147.3 2		LS-Limestone	H						ŀ		46	
Start of Z# Core  Start of Z# Core  B 2 2 Manh - Mechanican Geo - Geologist  Run 1  Cored 946  Rec 946  Loss 0.0  Time 16:30 - 17:00  Wased Oppth Sample 1 4825 2  4874 2  4879 2  2 4874 2  4879 2  2 4874 2  2 4874 2  2 4874 2  2 4874 2  2 4874 2  2 4874 2  2 4874 2  2 600 501  Mater Return 1  Run 1 to Run 6  Run 2  Cored 10.3  Rec 10.3  Loss 0.0  Time 1825 0.0  Time 1826 10.3  Loss 0.0  Time 1826 10.3  Loss 0.0  Time 1827 10.3  Loss 0.0  Time 1828 10.3  Loss 0.0  Time 1829 10.3  Loss 0.0  Time 1820 10.3  Loss 0.0  Time 1821 10.3  Loss 0.0  Time 1821 10.3  Loss 0.0  Time 1822 10.3  Loss 0.0  Time 1824 10.3  Loss 0.0  Time 1825 10.3  Loss 0.0  Time 1826 10.3  Loss 0.0  Time 1827 10.00  Wased Depth Sample 1828 10.3  Loss 0.0  Time 1829 10.00  Wased Depth Sample 1820 10.00  Wased Depth Sample 1821 10.3  1832 10.3  1832 10.3  1832 10.3  1832 10.3  1833 10.3  1833 10.3  1834 10.3  1836 10.3  1837 10.3  1837 10.3  1838 10.3  183	<b>1</b> /4		H		Ιl						′ <b>′</b> ′-	5H
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Run 1  Run 1  Run 2  Run 1  Rec 9.8°  Loss 0.0°  Time  16:30 - 17:00  Wased Orpth  Sampk  1782.5 2  477.4 2  2 487.4 2  2 487.4 2  2 487.4 2  2 487.4 2  2 487.4 2  2 487.4 2  2 487.4 2  2 600 And Run 6  Run 1 to Run 6  Run 1 to Run 6  Run 2  Cored 10.3  Run 1  Run 2  Cored 10.3  Run 2  Cored 10.3  Run 1  Run 2  Cored 10.3  Run 1  Run 2  Cored 10.3  Run 1  Run 2  Cored 10.3  Run 2  Cored 10.3  Run 1  Run 2  Cored 10.3  Run 3  Run 4  Run 6  Run 1  Run 6  Run 1		U- 10 - U- (010511)	H		Ц	Щ				Start of 24 (orz	:	
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Time 16:30-17:00  Wared Orpth Sample 1 482.5 2 1 487.4 2 2 487.4 2 2 487.4 2 2 487.4 2 30  Water Return  Much Brow  Core spin  Mach Brow  Core spin  Mach  Brown Mach  Water Loss at tw  SH at Top afflo  Run 2  Cored 10.3  Rec 10.3  Rec 10.3  Rec 10.3  Rec 10.3  Time 1:00  Wared Orpth  Share Loss at tw  SH at Top afflo  Run 2  Cored 10.3  Rec 10.3  Loss 0.0  Time 1:20-10:00  Wared Depth  Sample  192  Ryrite nodules.  193  194  194  194  195  196  196  197  198  198  199  199  190  Wared Depth  Sample  197  198  199  199  190  190  190  191  191		Loss 0.0'		١							:	
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March bear  Much bear  More Sitty Vag  More Provide  More Mech  More March  More More March  More March  More March  More March  More More March  More					- [					- pyrite	48/	•
Mechber  Mechber  Mechber  Sitty Vag  Sitty Vag  Morter Return /  Run 1 to Run 6  Water Loss at w  SH at Top of Ro  Run 2  Cord 10,3  Rech  Most Min Water Loss of to  Most Min Water Loss of to  Must Cord 10,3  Rech  Most Min Water Loss of to  Mun 2  Cord 10,3  Rech  Most Man and Most to Black  Thinly Laminated, soft to  Most Most Most Model  Sitts fore Losses and  Myrite nodales.  Man 2  Cord 10,3  Rech  Time  1:20-10:00  Wased Depth  Sample  1492 Pyrite nodales.  Man 2  Cord 10,3  Rech  Time  1:20-10:00  Wased Depth  Sample  1492 Pyrite nodales.  Man 2  Cord 10,3  Rech  Time  1:20-10:00  Wased Depth  Sample  1496.3 2	, =,	ill and to be	-[	١	- 1			1		**	-	
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The sity vag  Sity vag  Sity vag  Mosh Browl  Core Spin  Mosh Browl  Core Spin  Mater Return    Run 1 to Run 6  Water Loss at w  St at Top of Ro  Run 2  Cored 10.3  Rec 10.3  Loss 0.0  Time  Thinly Laminated, Soft to  Most am Hardy wy occ  Sits for Lenses and  Pyrite nodules.  Mater Return    Run 2  Cored 10.3  Rec 10.3  Loss 0.0  Time  9:20-10:00  Wased Repth Sample  3 493.7 2  496.3 2	2186	1 482.5	-	-		-				Mich.b-lo (	=	
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Sitty Vug  Sitty Vug  Mark Bond  Moch Bond  Corr Spin  Multiple Run 6  Run 1 to Run 6  Run 2  Cores Spin  My2—Much  Both Mech  Cores Mark  SH at Top of Ro  Run 2  Cored 10.3  Rec 10.3  Loss 0.0  Time  Thinly Lamianted, Soft to  Marked Depth  Sample  192 Pyrite nodules.  192 Pyrite nodules.  193 2  1963 2		•••		- 1	- [	-	16					1
Mach Brus  Gers spin	2/3,/	2 48%7 2		-	J	- [	0.				44	
Month Bool  Month Bool  Core spin  Mater Loss at W  SH at Top of Ro  Run 2  Cored 10.3  Run 1 Cored 10.3  Run 2  Cored 10.3  Run 2  Cored 10.3  Run 1  Month Electron  Missen	211,2	789,9 2		1	4	-	~		•	24 des	77	·
Run 1 to Run 6  Core spin  Mater Loss at W  SH at Top of Ro  Run 2  Cored 10,3  Rec 10,3  Rec 10,3  Loss 0.0  Time  Thinly Laminated, soft to  Modiain Hard, w/ Occ  Siltstane Lenses and  Pyrite nodules.		• •		ļ		-	1			. 511/4 449	=	
Run 1 to Run 6  Core spin  Mater Loss at W  SH at Top of Ro  Run 2  Cored 10,3  Rec 10,3  Rec 10,3  Loss 0.0  Time  Thinly Laminated, soft to  Modiain Hard, w/ Occ  Siltstane Lenses and  Pyrite nodules.		Water Ration	-			- [	10			- mech	40-	
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SHEET 25 OF 33 . A-59

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SHEET 26 OF 33 SI A-60

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SHEET 27 OF 33 A-01

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SHEET 28 OF 33 SH A-62

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YMBOLS	: V	WATER	EVEL AT	COMPLETION		1					ᅼ	- PARTIAL LOSS OF DRILL FLUID
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SYMBOLS: V	WATER LEVEL AT COMPLETION						-	<u> </u>	- PARTIAL LOSS OF DRILL FLUID

SHEET 30 OF 33 St. A-64

boring No. 25-5

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i	, 1	-SH 0.01 to 0:03	ſ	ı	1	1	-	I	ŀ	•
		-SH 0.05'					┙	ᆚ	_1	
YMBOLS		WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMI	PL ETI	ON.						- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID

SHEET 3/ OF 23 A-65

Detail Start   Complete   Detail for Surface E   Dottin N			NG NO255			rume					stalled
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Drilling Agency Inspector Drille Type Drill Type Drill Method Thickness of Overburden Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Depth Drilled Into Rock Total Surface Cover  ELEV.  SURFACE COVER  EAT. Drill Filled Veg Total Filled Veg			_		Den	um i	or a	SUN	-	_	3
DOWN Type  DATE Type  DATE Method  Thickness of Overburden  Dought Drilled into Rock  Total Depth of Boring  Dit of Boring  Ver. Inclined Deg  ELEV. E SOIL CLASSIFICATION  ELEV. E SOIL CLASS		-	·	1.	1		ļ <sup>-</sup>	11		8	ļ
DIT Type DAT Method Thickness of Overburden Depth Drilled Into Rock Total Depth of Boring Dit. o		-	· · · · · ·		1	ł	1		3	2	
SUFFACE COVER  50.7 Case I and J + 79.7'  LS			inspector	1 8	1	1		1 1	_	₽	
SUFFACE COVER  50.7 Case I and J + 79.7'  LS	Drill	Typ	)	Ē	天	ı		11	3	3	LABORATORY RESULTS
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SUFFACE COVER  SURFACE COVER  SOLUTION  MICH Construct of St.  Solution of	Thick	1655	of Overburden			g	2	삧	ই	亘	REMARKS
SUFFACE COVER  50.7 Case I and J + 79.7'  LS	Depth	Dri	led into Rock	9	15	₹	Ę	Σ	<u> </u>	\$	
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Consisted of the State Filled Vog   State Filled Vog	<u> </u>	1_	4				-	-		- 1	
### STEMANS   Filled Veg    ### A STEMANS   Transition Zencur/    List	<u> </u>	10	<b></b>				-	_ [		ı	•
### 15   Filled Vog   Transition Zone w/   Run 15   Carell 28   Rec 28   Loss 0.0   Time 11:48 - 14:05    ### Mesh & HALE, Dark Green,   Wased Oroth Elev Sample   G27:1 740    ### Mesh Mesh   Polanitic   Polani	E/.		- Commented of T				- 1	2	- [	ı	
State   Filled Vag	Ε,	100	<u>.</u> ]  .			[		V		J	_
Transition Zonc w/  Ls 22 - Mech Sty Elev 75.9-74.3'  Mech Sty Elev 75.9-74.3'  Mech (Waldron Shelz)  Cored 28  Rec 1.8  Loss 0.0  Time 11:49-14:05  Wared Orath Elev Sample  Q1-Mech Medium Here's  Delenitiz  March Delenitiz  11 625.8 72.8  12 630.0 71.1  12 630.0 71.1  12 630.0 71.1  12 630.0 71.1  13 632.5 65.6  6370 67.1  March Cored 10.1  Ranl6 61.5  Shoot fite, Hard of Shalz  Shoot Lord 10.1  Rec 10.1  Loss 0.0  Time 9:30-11:05	F	1-	الما		i i		Y	8	- [	- [	·
Ls are mech SHE/ev 75.9-74.3'  Mechan She/ev 25.9-74.3'  Mechan (Waldron She/e)  CH Mech SHALE, Dark Gerry,  Mased Depth Elev Sample  10 627.8 73.8  10 627.8 73.8  10 627.8 73.8  11 628.8 72.8  11 628.8 72.8  11 628.8 72.8  11 628.8 72.8  11 630.0 71.1  12 630.0 71.1  12 630.0 71.1  13 632.5 65.6  67.1  14 0 67.1  15 67.1  16 17 18 18 18 18 18 18 18 18 18 18 18 18 18	E					J	ı	1	-	- [	·
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Loss 0.0   Time 11:48-14:05	· -	144	<del>-</del> 1				- [		1	-	
## 19   Time 11:48 - 14:05  ## Much SHALE, Dark Gerry  ## Buch Medium Hosel,  ## Dolomitic.  ## 10 627.8 73.8  ## 630   Much Medium Hosel,  ## 630   Much Medium Hosel,  ## 630   Much Medium Hosel,  ## 630   Much Medium Hosel,  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   71.1  ## 630   67.1  ## 6	74.31	1	mech bee			1	- 1	ł	1	-	
## Mech SHALE, Dork Geren,  Mared Depth Elev Sample  10 627.1 740  10 627.8 73.8  10 627.8 73.8  11 628.8 72.8  11 628.8 72.8  12 Mech  12 630.0 71.1  12 630.0 71.1  13 632.5 68.6  63700 67.1  14 Odomite, Light Grey to Thirty, Hand of Shale  15 SH 0.021 Laninar and layers.  16 Mech 61.5  17 Cored 10.1  18 Mech 62.0  18 Mech 62.0  19 Time 9:30-11:05	_		- Mark (Walders State)	l	- 1	- 1	-	İ		- [	- · · · · · · · · · · · · · · · · · · ·
SH GR Medium Horr,  Dolomitic.  St. Gr. Mech  Me	=		The (" winter share)	į	·	- [		-	-	-[	Time 11:48-14:05
SH GR Medium Horr,  Dolomitic.  St. Mech Medium Horr,  Dolomitic.  10 627.8 73.8  10 627.8 73.8  11 628.8 72.8  12 630.0 71.1  12 630.0 71.1  12 630.0 71.1  13 632.5 65.6  63.6 67.5  13 632.5 65.6  63.0 67.1  By Mach Grant Medium Horr,  Run 16 61.8  Run 16 61.8  SH Dolomite, Light Gray to  Thirty, Hand we Shale  SH Dolomite, Light Gray to  Thirty, Hand we Shale  SH Dolo Landings and layers.  13 632.5 65.6  Cored 10.1  Loss 0.0  Time 9:30-11:05	-	1,,,	1 Mech	ł	- 1	ſ	- 1	-	1	İ	
SH GRAM Medium Hord,  Dolomitic  Mech Medium Hord,  Dolomitic  Mech Colomitic	-	4		- }			ı		1	1	Wasted Depth Elev -
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WATER LEVEL \_\_\_\_ HOURS AFTER COMPLETION ORL FORM 1202 1 June 1988 SHEET 32 OF 33 SH A-66

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WATER LEVEL AT COMPLETION
WATER LEVEL \_\_\_\_ HOURS AFTER COMPLETION ORL FORM 1202 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID >> - TOTAL LOSS OF DRILL FLUID

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المعملية المعملية	2 3	Crushed Grovel (0-0,4') Reddish Brown, SILTY CLAY Moist, Soft to Medium Stiff  (0,4'-4,5') Browish Red to Red, SILTY CLAY, Moist to Domp, Medium Stiff to Stiff (4:5-44,0')							9 % "Tricone Roller Bit to a depth of 49ft  Installed 6"Sch 80  P.Y. C. to a depth of  49ft, 1ft stickup  Changed to 434"  air hammer bit at  49'
									2 % Core Christsen NG-5 WL Core Barrel Using a surface set 25Ct 5N 35 Ø 38649 Type Ø 2Ø406676
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MBOLS:	*	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPL	ETIO	v			>	> - > -	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

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BORING NO. 15-6

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SHEET 5 OF 33 SI A-73

>> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

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SHEET 6 OF 33 SHL A-74

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SHEET 5 OF 37 SHI A-76

BORING NO. CO-5

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YMBOLS: 🔽	WATER LEVEL AT COMPLI	ETION					>	- PARTIAL LOSS OF DRILL FLUID

SHEET 7 OF 33 S A-77

>> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-6

Project Surface Elevation Datum for Surface Elevation Datu	BURII	NG NU. <u>25-0</u>								installed	
LOCATION N. E. DURING APPROV. DURING Appency. DURING Appency. DURING Method of Overburden. During Appency. Dur	Project	(A, 1, 1 <sup>-</sup> )									
Drilling Jones Inspector   Drill Type   Drill Method Thickness of Coverburden   Depth Office   Drill Type   Drill Method Thickness of Coverburden   Depth Office   Drill Type   Drill Method Thickness of Coverburden   Depth Office   Drill Type   Drill Method Thickness of Coverburden   Depth Office   Drill Type   Drill Method Thickness of Coverburden   Depth Office   Drill Type   Dr	Dete:Start _	Complete				<i>III 1</i>	or :	Sun	_		
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WATER LEVEL HOURS AFTER COMPLETION 202 SHEET 10 OF 33 SHI A-78

> - PARTIAL LOSS OF DRILL FLUID

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SHEET /9 OF 33 SHE A-82

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SHEET 15 OF 33 A-83

BORING NO. C5-6

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SHEET 17 OF 37 s. A-85

BORING NO. 15-6

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SHEET /8 OF 33 SHE A-86

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SHEET 2/ OF 33 SI A-89

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ORL FORM 1202 1 June 1988 SHEET 22 OF 33 SH A-90

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- 19/1		- [		ſ					· · · · · · · · · · · · · · · · · · ·
:   🗐	, 1	1		ı					Stl- Shalz
· <del>//</del> /	i	1		ł					Ls-Limestone
	ĺ	I			1				Dul-Dolomitz
798	1	- 1						1	
: ["=	j		1		1				BIP- Bedding Plant
799	i		l					ŀ	Mech - Mechanical Brak
E"'	į		l						Geo - Geologist =
		.						-	SLs - Siltstone
YMBOLS: V-	WATER LEVEL AT COMPLETION					_	Ŀ	ŕ	PARTIAL LOSS OF DRILL FLUID
<b>★</b>	WATER LEVEL HOURS AFTER COMP	LETIC	N				>	<u>۲</u> -	TOTAL LOSS OF DRILL FLUID

SHEET 25 OF 33 A-93

BORING NO. \_ CC-6

BUNING NO. 23-2			rume				Installed
Project //, T, P,  Date:Start // Complete //			tace um fi				
	_	Dan	um n	or a	SUTT	_	
Location NE	İ	1	1		1	١	8601
Drilling Agency	l _	1	1			3	9  ·
Driller Inspector	8	ŀ		11			9
Drill Type	15	天	1	L		3	김 LABORATORY RESULTS
Drill Method	길	Ž		5			
Thickness of Overburden	1 5		12	밀		8	AND REMARKS
Depth Drilled into Rock	8	<u>E</u>	ا≼ا	131	واع	4	≨l
Total Depth of Boring	ಠ	8	Į 🖲	삗	쁴	5	<u> </u>
Dir. of BoringVertinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	S	真	를	2	MONO
ELEV. F SOIL CLASSIFICATION	Š	금	뿐	3	SAMPLE TYPE	2	<u>K</u>
SOIL CLASSIFICATION  2/28' SURFACE COVER	┢				7	+	
	<del>                                     </del>			Ħ	+	+	Start 24 Core with
Mech Light Gray		l l	1 1		.	1	
501 = Med	1			. 1	4,1	1	Joy 228
+ Meeh				6	E	1	'
			ŀ	OX	٩l	1	Depth 500.1'
502 - Mech Light Gray				<u>^                                    </u>	-	ı	Eku 2/2,7'
E Med		ı		41	1	ŀ	· <del>-</del>
203 Light Gray		ı			ł		Run 1
F   107   -7"/ - 1		j	i				_
F   1			ĺ				Lored 9,9 Rec 7,9
Toy = Mech	i	- 1	- 1				Loss 0.0'
ا بر ایسال	- 1		ſ		1	1	-
5H June spin pyrite	ļ		- 1	-	1		Time 8:35- 9:30
105 Mech	1	ı		İ	1		Wared
1 1- 1- 1- 1- 1- 1- 1- 1- 1- 1- 1- 1- 1-	- 1	- 1		-			Sample Oupth Elev :
		- 1	0	- 1			No 12 = 2100
576-	- 1		1	-			No 502.8 210.0 1. 503.9 205.9
- SLS 0.01	- 1	- 1	V	ı	1	1	-
97 SLS 0.02 Mech		ı	12			1	2 5050 2078
	1	- 1		1			507.1 2057
Sts Mech		- 1	100	Į		ı	
DF - Ste Lonino 2			i	1	1	l	3 <u>507.7</u> <u>205./</u> 508.8 <u>204.0</u>
-SLSLon		- 1	ı			1	1
Corespin	ı	ı		1.	4	Ι.	4 508.8 204.0 509.6 203.2
- SLS Lanias	i	- 1			1		509.6 203.2
1	I	- 1		1	1		)
10 Mech	j	⊢		1		1	100 % notes Return -
Skelonius			- 1				Run 2 Cored 4.8'
- Mead - 511 - 515 Lamines Mach	ı	- 1	- 1				Rec 4.8 Loss O.O' =
- SLS Lemines Mech	ı	- 1	H	1			1 1186 110 2237000
	.	1.				ı	Time 11:20-14:30
(New Hidany Shale)			01				Sample Depth Elev
1 2 (11)		1`	`	1		Ì	SOMPIT UIDTH Elev ]
SHALE, Brown Black to Black,		1	7	1	IJ		No 511,1 201.7 5 514,7 198.1
Thinly Laminated, Soft to Medium Hard, m/ Occ Siltstac	1	15	10				5 514,7 198.1 7
Medica Hand Ma Cill	ı		001	İ	H		4
STIF	- 1	13	2	1		ı	1 4
SLSLaminar Leases and			1	1		i	1
- Mech proite nadules			-				100 % Geter Relica
			$\neg$			- 1	Run 3 Cored 5:0 =
1 mech.	ļ					- 1	
5/63	ļ		م	† 1			Rec 5,0 Loss 0,0
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	ļ	1.	8			Į	
4		13	7 2	П	1		<u> </u>
5/7.		1	12	П		ı	Time 15:30 - 16:00
		K	Γ	IJ		Ì	ward D. H. E.
		N	И			- 1	Somple Depth Elev
518 mech stateminer	ŀ	100	۱,			-	No 5,500 19481 3
- Daninae		3				l	$6 \frac{518.0'}{521.7}, \frac{194.8'}{191.7}$
5/93	- 1	1	1			1	521,7 171,1
		1	1. 1				Ŧ
SLS Lamiage Zone	Į.	1	-		$\perp$		-]
10°71/				Ш	$oldsymbol{\perp}$	l	
MBOLS: V WATER LEVEL AT COMPLETION							- PARTIAL LOSS OF DRILL FLUID

SHEET 25 OF 33 St. A-94

		NG NO			rume					stalled
Project				Deti.	ace m f					E .
				<del></del>	<i>an 1</i>	1	T	rest.		
			1	1		1			1088	
_	-	ncy	_	1	1	-		3	12	
Driller _		Inspector	ğ	1	'	1	1	1.	10	
		,	15	7	1	<u> </u> _		温	肾	LABORATORY RESULTS
orlii M			Ş	Ž	힏	頁		E	E	AND
		of Overburden	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIGD		믭	MOISTURE CONTENT	NDWATER-FLUID	REMARKS
•		d into Rock	1 8	Ď.	[≩	13	I≿	W	I≨	
OTH D	epm	of Boring	ರ	9		쁘	쁘	15	9	
JIr. OT		ingVertinclinedDeg	1 8	8	18	9	9	쥰	3	
LEV.	Ē	SOIL CLASSIFICATION	S	교	Ë	3	SAMPLE	12	ğ	
928	DEPTH	SURFACE COVER	ļ —			Г	Г		Ť	
	520	-0				Γ				
•		-5250.04	1		i i					
1965'	12/-	- SLS LORINA C - SLS 0.04		1						
1113	1	. (Jeffressarille Limestone)	ł							
	5	( Seturation Lamestone)		1						T
	722-	Limes Toney lan Brown to		]				$ \cdot $		Trace of Hydro carbon
-5	:	Limes toney Tan Brown to  -sty Lt Grayn Hardy Fossillerons,  -much Posons	1							in Jeffersonville
	523	Mech Porons					اردا			Limestone
	:	Sty					4			Some Sections will
	زرحا	<b>'</b>	j .				1/8			not pass wire Test
18,3	27	- Mach					["			for Jeffer paville
, ,	:								-	Limes tone
	25	Much Sholey Limestone						ļ	<b>.</b>	
	:	Shale							- [	Runy
. [	L :	Mech				I		J		Cored 10.1'
j	26-							- 1	١	Rec 10.1'
	:	<i>5ty</i>		l		ı		ł	- 1	Loss O.D
-5	تري	<i>'</i>		l				-	-	LOSS U.V
- 1		BIP Opto			İ	1				Time 16:30-17:30
I	_ :	-SALANIARY -STY BIP OPTA			ı			-	-	1, me 16, 30 = 11,30
ŀ	-350	- Sty OPTA			- 1	J	-		-	
ļ	-	L-C+1.			- 1	-1				
	29_			J		- [	4	- 1	-	•
	=	3/7 /,24	.	1	-				-	
ĺ		- Vent For From		- 1	- 1	.[		ļ		
F	72/ <u> </u>	- Agrillous Parals Lines ton z - Vert Fracturz - BIP	İ	- [			-	ı	-	•
ı	-	-Sh Lominar			N		١		-	
Ŀ	7/57	- I COMINE C		ļ	0					
ſ		· .	.	J	0					
- 1	_ 1			I.	$\Box$			-		
ľ	72-		.	ľ	ノ	-		1	1	
i	- =	- mech Geo			19				1	•
k	72	יויזניו שינט .	ĺ		17	7		1	1	
- [	=	- Sh Laninge	- 1	1	200	; [				
- 1			Ţ	-	1	۱,			1	1447 8 + 1 1 +
þ	7/-	- Sh Lamina c	1		:	۱ ۲		1	1	100 To Water Retain
	3	- Meet Very Agrilleons Linestone	[			1				·
	الحر	Mech Coy included Lights TOAL	- 1	L		1	1	1		<del>.</del>
- 1	3	Ì		Γ			1		Γ	Run5
ļ	_ }	i	- 1	-	ŀ	1	-			
. 1	74]	· .			1					Cored 10,1
- 1	3				- 1			1		Rec 10,1
, k	72	İ	- 1			İ				LOSS 0.0
ľ	~7	1	1				I	1	1	<del>-1</del> 7
	਼ ‡	- Mech Geo		-  -	7			1	1	Time 8:30-9:00
5	74	1	- 1		7		ļ			5% Orilleston at the
	4			18	10		1			<del>-</del>
_	<b>,</b> ,‡	- Mech Geo	I		00					Start of run
P	"=	•		-13	0					80% return at endot
	4	1		- [	1			-		FUN
le-	<b>201</b>		- 1	- 1	-1		1		L	•

SHEET 27 OF 37 & A-95

BORING NO.

Project U. T.P.			חטל				Installed
Date:Start/ Complete/_/	•		face				
Location N F		UEL	un i	ior	SU/	7BC	ə 5
Drilling Agency	٠ ا		1_	1			880
Drillerinspector	1 _	1		1	П	3	2
Drill Type	USCS CLASSIFICATION	1	1	1	П	S	
Drill Method	15	1 =	j		П	7	LABORATORY RESULTS
	5	12		5	П		AND
Thickness of Overburden	1 5	6-INCH	g	9	ابرا	쥥	REMARKS
Depth Drilled Into Rock	9	5	\$	5	اج	ပ္ပု	Z REMARKS
Total Depth of Boring	1 3	BLOWS PER	RECOVERY/RQD			랄	<b>3</b>
Dir. of BoringVertInclinedDeg	9	3	8	군	2	Ĕ١	<u> </u>
SOIL CLASSIFICATION  772.87  SURFACE COVER	<b>⊣</b> છે	2	监		3	ð,	2
172.8 SURFACE COVER	+=		-	8	8	3	<u> </u>
	<del>↓</del>	Ш		Ц	4		
F. J 4 ( CIMES 10AC)		i i			9	- 1	
E Limestone, Light Gray to Gray,					Z	-	1
Medica Hard to Hard					<i>,</i>	-	· .
F CULTURE TO THE PROPERTY AND THE PROPER	1		ı	V	8	-	1 :
5/2 Slightly Vaggy to Vaggy	1 1	- 1	- 1		١,	1	:
FLS   Mech m/ Porons Zones St 1.14	1 1	į	Į	- [		1	-
but the Classification	1 1	- 1	- 1				
Ls Mech m/ Perons Zones, Stylolites, m/ Occ Shah Lominazor	1 1	- 1	ı	- 1	1	1	-
F Total Ded W/ Occasional	l i	- 1		-		1	1
chart nodale	ii	- 1	- [	1	1	İ	]
F 9774		- 1			1	1	· -
F   1	1						] =
- much			- 1		į.	1	1
E 1" 1"""	1	⊢	-			1	
Sh. Leminar Zone			- 1	1	1	ı	Run 6
- SYC- ZONC	- 1		- [	1		1	Cored 10, 4 Fa. Bettom
Mech		- 1	-1			1	Rec 10,4
Stole Laminas 0.01 to 005 ipart	- 1	1	ı	-			]
	- 1		- 1	1		l	Loss 8,0
10004570	- 1			1	П		Time 9:30-10:00
BIR Open Very Porons		-	-				11mt 7, 30 - 10.00
Orath Elev					ı	1	1
547.5 115.7	- 1	1	I	П			#
547.5 165.7 - A/Para 558.2 157.6	- 1		1			-	4
- A/POPTA 558,2 154,6	- 1	1	1			- 1	Some Sections of
- Mech	- 1					-	
BIP Open Sol	ł	1			- 1	- [	core will not pass
	- 1	1					· · · · · · · · · · · · · · · · · · ·
-LS STA SALamin or SA-0.01'	j	1.	4 1			-1	70% water Return
Solation Sh. 0.01	ł	0	1 1			1	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
		0	1		-	1	for rest of Burne
mesh	- 1		Ш	- 1	-	-	- 4
-sty	- 1	20	101		-	1	7
BIP Solution	- 1	10	0			1	1
± 5ty	- 1	6		1	1		7
7	1	100	7	1		1	<b>4</b>
ESTY BIP	- 1	1	1 1	1		ł	
1 - 3 - 3 - 3	- I	ł				1	
	- 1	1 1	1		ı		1
1-Mech	- 1		- 1				7
572			- 1	1			940 7
- Mech			- [	1		i	
1 1 1 1	1 1				1	1	ored 10.4
557 - Much AIP Para Solation				1		1	Rec 10,4
1 3		7	1	1			0150.0
SYL ST BIP Open Solution		6				_	3
1,10		10	1	1			Time 10:05-10:35
1 1-5/ /		N		ı			7 (1,0)
5 57 Con Sain Sty	1 1	600		1			love out of spre
Ish Laminer	11	00					for sime sections
1711-57V	11	1					" SIME SCETIONS 1
IBOLS: WATER LEVEL AT COMPLETION	44	丄					
WATER LEVEL HOURS AFTER COMPLE	TION				>	-	PARTIAL LOSS OF DRILL FLUID
FORM 1202	LION				<b>&gt;&gt;</b>	-	TOTAL LOSS OF DRILL FLUID

SHEET 7 OF 33 SH A-96

BORING NO. CO.

Project	NG NO. <u>(5-6</u>		Surf	ace	Ele	WE	tion	<u>_</u>	stalled
ate:Start	/ / Complete / /		Date	ım f	or s	Sur	fac	<b>1</b>	5I
ocation I	E				1 -		Γ	9	
	ency		1	1	1		=	88	
riller	Inspector	z		l	1	l	E	旨	
Orli Type		[ 일	_	I	İ	ı	Ę	15	I ABODATORY BEGIN TO
rill Meth		🗧	호	ŀ	æ		圓	岸	LABORATORY RESULTS
	of Overburden	l 운	Ĭ	l 유	뗾	l	Ž	唐	AND
		<u>\$</u>	12	Ĕ	Œ	2	8	ᄩ	REMARKS
	ed Into Rock	₹		È	물	=	빛		
otal Dept ir. of Bo	r of BoringinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	뮕	문	31	2	
LEV. 52.8'		SS	BLO	EC.	8AN	SAMPLE TYPE	SIOM	aRO	
52.8'	SURFACE COVER								
45 56	1-5h Leminat Sty							П	
->   ·	1-54 Laminas	l		l	H				
5181 0	•		1			[ ]			
7,6	Vag Mech Sol	l	1						
- 1	ShLamina E	1	[	l	Į į				
Z.	Finesh Paraus Zana				H	1			•
				ľ		_/			
J	10.03' Death Fl	l				2	İ		
56	5h 0.03" Depth Elev 5h 0.01" Depth Elev 5h Laminac 5775 15/18"	1				ا را		Ιĺ	
1	15/6 15/18	l			1	4			
	577.5 / 135.3				ll			Н	
524	=Sh Laming =								
Í	<b>1</b>							ı	
·	Vag								
122							į		
1						ı		i I	
رسدا	干5ty		ا ا						·
1366	<b>1</b>		}					H	Run 8
1								Ιİ	Cored 10:0
77	- BIP Sol Core Spin		ll						•
<b>"</b> "	۱ ا						- 1		Rec 10.0
İ	<b>1</b> -54y						١		LOSS 0,0
.5 58	Vas BIP Solation						Ì		
["	50/4 710N		l I			- }	ı		Time 12/30 -19/30
1	510.03		i I				- 1		1111.6 12.70 -17 3V
569	540.01					4	١		
1	Salaminas					- 1	-		
	In Care Cala				}	- [	ļ		corrout of sprc
200	<b>-i \</b> 1				1	1	1		•
	ShLaminar			N	- [	ı	-		
57/	<del>1</del> /,		l	0	- 1	j	-	- [	
<b>₽</b> //:	The state of the s		<b> </b>	0,	- [		- [	-1	
- 1	-5h Laminaz 0.02 -0.05 apart -	.	ĺ		_ [		- 1	- [	
h,	4-81P			7	$\Box$			[	
P/2	<b></b>	Ī	- 1	1	81	ı	ĺ	[	
ļ	<b>1</b>		- 1	00,	0	ŀ	1	- 1	
573	<b>1</b> , l	1	- 1	3	X	-	- [	-	
- 1	_5ty50/	Ì	J	7	5	- 1	- [		
}	- 5 ty So / - 5 h Laming c - 5 h 0.03	ļ	ı			- [	-		
571.	4 * ' * ' 1		- 1			-	-		
	- BIPSA Leminac		- 1		4		-		
_	7	- 1	- 1	I			١	ı	•
p75.	- BIP Open Solution	İ	J	- 1	- [	I	1	1	
Ì	sty	- {	Į		-			1	
بيا	mech	1	[	1	٠ [		ł		
P7.		İ	ı	$\neg$		-	İ	ı	D //
1	ShLaminas	ļ			Ī			1	Run 9
. 672	-5ty	ı	ł	1	ı	-		.	Cored 10.1
5.31	] '	j	- 1	- 1		1	-	1	Rec 1011
<i>"</i>	- Sh 0.05'	ļ	ı	9		1	1	-	=
575-		j	l'	74	1	-		1	Loss 0.0
Γ"	<b>-</b> 177	- 1	1	\	-	-	-	-	
į	₹ I	.		И			ł		Time 13:40-14:20
579-	<b>1</b>	- 1	I	16	-			-	
ľ	<u> i</u>	- 1	1	0	1	1		1	Occassional Small rugs
1	Sh Laminas	- 1		9	1	1	1		
	5			1	- 1	- 1		- 1	

SHEET 27 OF 33 SI A-97

BORING NO.

	4. T.P.	•		rume					stalled
Project	/ / Complete/ /	•		lace um f					<b>3</b>
Location N_			7	T	<u> </u>	T	Ï		
	ncy	1	1			l		880	
	inspector	z				Ι.	3	15	
Drill Type_	•	∣₽	1_				5	병	
Drill Metho			I	1	æ	1	包	亡	LABORATORY RESULTS
	of Overburden	1 2	Ī	8			Ž	监	AND
	d Into Rock	<u>\$</u>	E	Ĕ	3	Ē	8	E	REMARKS
Total Depth		13	1 2	€	Z	F	분	₹	
	ingVertinclinedDeg	1 0	2		=	2		3	
		J JSCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIQD	SAMPLE NUMBER	B	ö	2	
/32,8"	SOIL CLASSIFICATION	13	<u> </u>	2	8	8	2	ਰ	
/32,84	SURFACE COVER	-	-	_	Ш	Ш		Ц	
190		1		· .					
	Mech	1	١,						Some of love on tol
517-	_meeh	1		١,			i		Spre
	0.05 Chert Si Laminge					J			,
582	-St Laminal			l					Core in Ran 9 nos
F   1	-Chert Sh Laminac	İ				J	ļ	J	
F	-Chert	İ					·		Occassicnal small ungs
						- 1	ı	ĺ	
F   4	-Sh Lominaz					- [	- 1		:
59%	Sh Sh 001 Sh Laming z			ı	- 1	- 1		-1	_
F   =	Sh Lamine -	1		- 1		- 1	- 1	ı	<del>-</del>
		1		ŀ	- 1.	.7l		-1	
F 7"	-5 ty			i	ŀ	41	1		
F 1 4	-Sh 0.UI			- 1		4		-	<b>-</b>
F SPC	- Mec h	1 1			ľ	3	1	L	
F   1				ı	- 1	- 1		١	Run 10
E	-Sh Laminae / Chert	1 1	ı	- 1		- 1		1	Lored 4,51
E 17/3	-sty	1 1	- 1	- 1	ı		ļ	1	Rec 4,35"
EL5 1.3	- A A mal	1 1	ı	N	1				
- 77-I	- 0.05 2055	1 1		0	-	1		1	Loss 0,15'
<b>!</b>   <b>1</b>	= Loss O. 1' Sh Cort Spin	1 1	ŀ	0,	-[	-	ı	1	Time
572	<b></b>	1 1		И	1.	4		ļ	9:45-10:35
F   #	-5ty	1		50	Ι.	1	1		· · · · · · · · · · · · · · · · · · ·
F		1 1	- 1.	2		1	1	1	Corr out-of Sprc
F 177-4	-Sh 0.01' cl / '	1	- 1	1			1	1	亅
	-Sh 0.01' Sh Laminaz	] ]	ŀ	-	-		ļ	┝	
L 19/4	•	]	ı		,	1		1	Run //
-   1		].		ľ	' 1				Cored Si7'
= [,1	61 6 02 1	1 1		d X		1	ļ	1	Rec 5.7'
- P <sup>72</sup> -F	-Sh GiOZ' -Sh Laminaz		- 1						3
		1	ı	٢		1		14	Loss 0,0'
- 573	Chert		-						Tine
:   ₮	Sty Shool Mech			0					
5942	Sh 0,02'		-   `	1	İ			1	11:10-11:40
<b>4€</b>	Shlomings		1	1	1		1	1	्रच
. ! =	Chert Mech		-   6	24				1	3
	Mesh			2		1			
:   ‡	SCA ALL			7	1				3
5%	SALO Minor	]	1	1					E
	540.01			7			1	1	41/2
. 592	54 Lamina e								
[二]		}	-				Ì		Cored 10.2'
	- Shilains of a series		15	ź	1				Rec 10,2'
- W-	- Shlaming Sh 0.01' w/ chert between			`	1			1	-059 0,0'
1 1			1.	K.	l		1	ı	. 1
599	sty		15	9				۱ ′	Time 12:05-12:30
E'I			1 2	3	-	1		ĺ	4
[ <sub>-</sub> ]	54 0,01	1		1		1			
YMBOLS: The	WATER LEVEL AT COMPLETION				Ц.			ᆫ	
	WATER LEVEL HOURS AFTER COM	PLETIO	N						PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID
RI FORM 1202			•					_	TOTAL EGGG OF DESIGN FEDER

SHEET 30 OF 33 SH. A-98

BORING NO.

RO	Kii	NG NO 23-76		Instr						stalled
Project				Surfa Detu						37
Date:Si	art_	Complete		Den	777 N	or i	34		_	3
		E			l				1088	•
		ncyInspector	7		l			3	-	
Driller _ Drill 1	_	•	፬	l_	l		l	Þ	9	A DADATORY OF CHILD
Drill M	••	<del></del>	X	5		æ		9	ij	LABORATORY RESULTS
		of Overburden	臣	15	8	12	ш	Z	6	AND REMARKS
		d into Rock	88	<u>E</u>	E	3	토	ŏ	Y	HEMARKS
•		of Boring	\$	2	<b>E</b>	Z	늡	H	₹	
		ingVertinclinedDeg	69	3	8	2	급	E	3	
ELEV.	Ē	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	₹	SAMPLE TYPE	₫	GHO	
112,8		SURFACE COVER		-	-	-	8	₽	۳	
112,0	600				┢	H	Н	-	Н	
		1 <sup>-7/9</sup>								•
-	2/1	-Sh BIP Corr Spin							П	
	נ "ו	Sh Lamina e	ĺ	1			H			
	ا ا	-sty								
-	602	1								
<b>-</b>	:	_5+y								
<u> </u>	607	Care Solo								1.4
<u>L</u> 5		Core Spin Sty Stleminoe								Change bit for Run 13
Ē ,	604	Sty Lore Spin								Christenson Imprognated.
	r :	€ 5+y								T Anhala Clas
-		- Mech								Type \$ 2646 5132
-	605									CBH NGSWL 2,985 -
-	[ :	-Sh Lominaz								Green
<u>-</u>	106	PIP STY								(4175-027574
-	:	SALOMINAL			$\vdash$					SN: 35-037574
105.6	//2	Sty mech			•					Rnn 13
105,6	7			1			ı			Cored 10,2
-		Core Spin Porous to Very					ا۔ ا			
-	605-	Vas Corespin Porons					ź	1	۱	Rec 10.0'
-	:	Corespia Orpth Elro	1							Loss 0,2'
-	609	Solution. 607,2 105,6					1			7: 12:110 = /2/20
=		- Cons Coss 0,2 2/50' 978								Time 12:40-13:30
	110	- Solation Mech	i			Ž		1	١	
-6	-	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1			30				Corc from 606,4 to
•	ء,,, =	-Core Spin	- 1			X				6072 off size cur
-	ľ″=	Core Sain.				7			1	to bring cored twee -
	:	-BIP Open				4			-1	Oriller Change care bits
-	6/2	2/2						ļ		and was raising and icamin
	=	חזקט יון נו	l		0				-	drill string
_	613	RIPPORT	J		0,90	١	1			
:		Turin I	1		2		- }	ı		H25 over in person
:	٠,,, -		į	ı	<i>\</i>	۱ ،		ı	-	Zone
<del>.</del>	<b>6/7</b>	- Spin solation	İ		14	1		ı		
,,,	-	AIPOPTO		Ì	20			١	-	Core Logs between
97,8	615	-540,01'			1	{		1	-	loss spins
	3	Sty Core Spin	I	1			- [		- [	(1)
_	6/6	Esty CLAN'	ļ			- 1	-	1		<u>.</u>
	3	-517 -30001	ļ	-	_ [	- 1	- 1	ı	ĺ	
7.	,,,	-Sh Laminar Mech	ı	ŀ	$\dashv$	ĺ	ł		ŀ	A IV
L'5	77-		- 1	1		- 1	-		-	Run 14
٠	=	- Corc Spin	- 1			-				Cored 10.0
- 1	618-		I		1		1	-		Acc 10.0
	1		Ī		7		-	1		Loss 0.0
	119	-BIPWISH CLASS	- 1	- 1	16	-		-		•
· 1	"	-BIP WISh Sh 0.02'	.		8	-		-		Time 13:40 -14:30 -
: <b>i</b>		-STY BIPUPIN	I	J	12	- [		-[	1	:
YWBOL	•///	WATER LEVEL AT COMPLETION	1	1					ᅼ	- PARTIAL LOSS OF DRILL FILLE

WATER LEVEL \_\_\_ HOURS AFTER COMPLETION

>- PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

Project Date:S Locatio	t	U, P, T, 		Surf					<u>_</u>	
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-	-	ncyinspector	2	1	İ			3	•	
Driller .			₫	<b> </b> _		Ι.		٤		
		<u> </u>	¥	5	I		Ι.	恒	2	LABORATORY RESULTS
Drill k			윤	<b>  ₹</b>	유			Įξ	TER	AND
		of Overburden	<b>5</b>	2	Ĕ	三	<u>.</u>	8	E	REMARKS
•		d Into Rock	3		₹	Ę	TYPE	끭	₹	
Die of	Jepui I Bod	of Boring	ਠ	8	🚆	삗	ļ	T	Z	
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	3	BAMPLE.	MOISTURE CONTENT	<b>AROUND</b>	
ELEV.	E T	SOIL CLASSIFICATION	5	<u>m</u>	Œ	3	8	3	ਰ	
928		SURFACE COVER		_	-	Н			Н	
	W.	Sty		1		1 1				NQ Found to or
	1,27	Sh Coming c Sh Court 0.03								hung on 6/28
-						l				419114, 411 4120
· •	:	- Core Spin - Sheet				H		1		Removed NX Cosing
-	122	-51 0.02						ł		and over drilled
	]					[				NO casine w/ 3/2"an,
_	27						ļ			The Constant of the state of
_	73							-		Cosing to a depth of
	3	- St. Laminar Mech					١	-		616 N' Elev 968'
•	624	- Mech Geo					-		ļ	CIENCE ICE I SIN
	-						- 1			
	البريا	-Mech Sh Loming :			Ì		- ]	- 1		
1.	[7]	Sty S" Loming t					-	- [		
45	1 3	Sh Lambanz 0.01 to 0.07' 0.01 to 0.05 apart	1					ı		
	[26-]	0.01 to 0.05 apart	-		1		١	-	١	•
	ΙE	Mech				- 1			ļ	7/6
	222	-Moch Sh Laminas Mech	l	- 1			ź	-	-	Run 15
į	["]	-6-1	l	- 1	- 1	ſ	,	ı	۱	Cored 9,9'
ļ	1=	-BIPMech		ı		Į,	*	-		** *
·	1287	_ B/P ·	- 1	ı	. ]	- 1	١,			Rec 9,9'
			- 1	1				-	-	20550.0
	28	_ Mech	l		1	4			-	
	4	i i	ļ	İ	L	9		Ì		Time 8:40 - 10:20
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- 1		= Sh_ Mech	.			7	1		-	World Depth Elev
- 1	וב ו	ETA Meen	- 1	- 1	- 1			1	1	Sample No
1	9/-}	> 5/ 2	- 1	ı	ľ	١,	ļ	1		
	1	> 5h Zone 0,01-0,03'	• [	- 1		-	1	1	-	7 632.5 80.3
	672	į					1	1		637.9 78.9
80,3	= =	Mech	- 1		9	1	1	1	ļ	
	્ર,‡	(Wuldron Shale)	- 1	- 1	11			-	1	8 <u>634.4</u> 78.4 76.6 -
ľ	77-	(45,000,000,000,000,000,000,000,000,000,0		- 1	1		1			636.2 76.6
- 1	#				1			1	1	;
یل , , ر	/ <sub>7</sub> /	-mach CHAIF Day	1		1	1			ļ	<u>-</u>
5 H	#	SHALE, Dark Green,			00%		1			· .
	,,, <u>,</u> 1	- AIP Medium Hard,	.		7				1	:
f	" <sup>7</sup> 「	Polanitic	ļ		-				1	-
ł	4	-			.		Ī	1		
1	34		- 1				1		1	_
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. Ŀ	723	1						1	ļ	R=16
ſ	<b>T</b>	ł						1	1	Cored 10,7
	. ]			-   1	0			1		Rec 16,3
K	38	4		1,	1					
1	3	Mech		1	1				1	6055 0,0
k	393	I	- }	-14	7					Time 10:30 - 11:10
٣	~	j			200	1			-	17:00
],	Env			`	7				1	-
MBOLS:		WATER LEVEL AT COMPLETION			_1_	1		1	Ļ	- PARTIAL LOSS OF DRILL FLUID

SHEET 77 OF 32 SH A-100

DU	أأث	19 NO236			ume					stalled
Project	!	u, T, P.		Surf			_			
Date:S	tert _	/ Complete/		Date	ım fi	or i	SU	Tac	_	J
Locatio	n N_	<b>E</b>	Í	1		1	1	1	<b>6801</b>	
_	Age	ncy	i	1	l	l	1	3	2	
Driller .		Inspector	8	1	1	i	ı		₽	
	Type_		Ē	天	ĺ		1		3	LABORATORY RESULTS
Drill A			δ	ĮΣ	ء ا	5	i i	Ę	#	AND
		f Overburden		4	ğ	9	삧	Ŗ	핃	REMARKS
		into Rock	👸	5	≥	١Ş	Ε	2	3	
Total D	epth)	of Boring	3	0	買	ш	ш	5	₫	•
Dir. of	Bori	ngVertInclinedDeg	×	Ĭ	Š	틸	릴	ST	Ž	
ELEV.	TE	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	3	Ž	Ē	띩	
72.8"	DEPTH	SURFACE COVER	<del>                                     </del>	一	┝	۳	-		判	
	140.	· · · · · · · · · · · · · · · · · · ·	<del> </del>		-	Н	Н	Н	┥	
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E"	141		l	١.						· /
71,4	///						.,	ll	ı	Waxed
E	1 -	· (Laurel Dolomitz)					4	l		Semple 5
F	142	(======================================					4		- 1	No Depth Elev
E	:		Ī				6			2//
F	///>	- Mech Sty	1			H			-	9 636.2 16.6
F00/	1.7.7	······································				H			- 1	618.3 74.3 T
F	:	Dolomite, Light bray to White, Hard w/ Shale Laminae and layers w/  sty Occussional Stylolite  and Oark Bands							- 1	9 $\frac{636.2}{636.3}$ $\frac{76.6}{74.5}$ 10 $\frac{636.3}{642.9}$ $\frac{74.5}{69.9}$
L	14:	Astribute to the second			1				- 1	10 638.3 74.5
F	=	WATER Hard W/ Shalt								147.9 [7.7]
Ė.		Laminax and layers wl								01211
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Ŀ	=	- Sty UCCHSSIONAL STYLOTICE							- 1	-
Ł	645	had Vark Bands							- 1	
Ε.	1 -							- 1	- [	
660'	]3	->TY_Sho.03'				$\sqcup$		┙	$\bot$	
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SYMBOLS	: <u>Z</u>	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COM	D. —	<b>-</b>				_	>	- PARTIAL LOSS OF DRILL FLUID
	•	WATER LEVEL HOURS AFTER COM	rleTi(	UN				•	<b>`</b>	- TOTAL LOSS OF DRILL FLUID

SHEET 43 OF 33 : A-101

>> - TOTAL LOSS OF DRILL FLUID

BORING NO. 25-6

	_	MG NO			rume				Installed	
Project Date:	st Stert	6 151 93 Complete 7 1/2/ 93			ace um f					
Locati Drillin Drill Drill Drill Thick Depth Total	ion N g Ag Type Meth ness Drilli Depti of Boo	Acer. Hollow E Ft. Kack, Ky ency Bayle: Bree Stillwell inspector forces	JSCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	AMPLE NUMBER		CONTENT (%)	LABORATORY RESULT AND REMARKS	s
706,4		SURFACE COVER		_	=	8	8	=	<u> </u>	
702,4	1 · · · · · · · · · · · · · · · · · · ·	Lt Brown, SILTY CLAY, Wet, Soft to Medium Stiff (0-4)							9 14" Tricone Rose Bit to a depth of 413'  Installed 6" 5-h 70 P.V.C. 13  a depth of 43	
701,9	' ;	Limestone, Boulder (4-5')								التتبا
	7-8-	Reddish Brown to Dark Red,  SILTY (LAY W) Chert  Fragments, Damp to  Moist, Stiff to Very  Stiff								
	9- 10- 11								2 Ho Core drilled using a Joy 22 and 312 Casing for 495 to Surface	
	13-	/							2 /g" (ore (495-535') Christsen Impregn	ماستولية
691.9'	15-3	(5-15)							Type \$ 204\$ 5 13	2 ]
-	//	Reddish Brown, Fine SANOY STLTY CLAY, Moista Stiff							C'BITNGSWL 2,985 RSG-GM 5N 35-031574	- 1
	1811	(15-39')							(535-636.7') Impregnated Bit	1
	19 20								C18: + NGSWL 2,985 R5G G11 5N 35 Ø 386 Ø4	70.
YMBOL	S: 🔻	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	LETIC	)N		•			> - PARTIAL LOSS OF DRILL F	

SHEET \_/ OF 32 SI A-103

BORING NO. C5-7

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Drill	ling	Agen	cy	<del></del>			- 1				t		اح	8	
Driii D-0	er _			Inspe	ctor		- 1	Š	1		L		릔		
Drui D-III		/pe					- 1	Ĕ	天				뒮	31	LABORATORY RESULTS
UNII Thia	M	9010Q	<u> </u>				- 1	2	١ž	۵	5	1	Ę	2	AND
Doo	at in	SS OF Velice	into P	urcen			-	8	•	2	3	쀮	힔		REMARKS
Total	4 C	nweu with a	WILL TO Pode	7G(			-	<b>Y8</b>	Ě	1	3	Σ	<u> </u>	≨l	
Otr.	of .	Borin		Vert	Incline	d D	99	ಶ	/8	VE	빌	삘	2	2	
LE		Ē		SOIL C				USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	MA	SAMPLE TYPE	MOISTURE CONTENT (%)	CHOUNDWATER-FLUID LOSS	
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SHEET 2 OF 22 SHE A-104

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		gency		1	ŀ	ł	ĺ	1	1088	
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Drill I	Meth	od	<del> </del>	₹	ļ	ــا	ı	面	근	LABORATORY RESULTS
		of Overburden	윤	1 ]	18		<u> </u>	Įξ	Œ	AND
		led Into Rock	8	2	Ĕ	Ę	٤	8	15	REMARKS
Total L	Dent	th of Borina	3	<b>] 2</b>	Ě	ž	۴	뿐	₹	
Dir. of	f Bo	th of Boring pringVertInclinedDeg	2	2		٣	뿌	P	물	
ELEV.			USCS CLASSIFICATION	BLOWS PER 6-INCH	8	3	3	MOISTURE CONTENT	GROUNDWATER-FLUID	
	1 0	SOIL CLASSIFICATION	5	五	RECOVERY/ROD	8	8	Ĭ	B	
6.66.9	ق ۲	SURFACE COVER								
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SHEET 5 OF 32 . A-107

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SHEET 9 OF 32 : A-111

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SHEET \_\_\_\_\_OF 32 SHE A-112

BORING NO. 15-7

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SHEET // OF 32 s A-113

BORING NO. <u>C5-7</u>

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SHEET 12 OF 32 SHLA-114

BORING NO.

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SHEET /2 OF 32 A-115

BORING NO. 25-7

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SHEET 14 OF 32 SHE A-116

BORING NO. \_\_\_\_\_\_

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SHEET 15 OF 32 SI A-117

BORING NO. \_\_\_\_\_\_

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MBOLS	: ∑	WATER LEV	EL AT COM	PLETION					-	•	_	>	- PARTIAL LOSS OF DRILL FLUID
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SHEET /7 OF 32 . A-119

BORING NO. 15-7

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MBOLS	: ♥	WATER WATER	LEVEL A	T COMPL HOUR	ETION RS AFTER	COMP	LETIO	N				> >	> -	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

SHEET \_\_\_\_\_ OF 32 SHI A-120

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SHEET / OF 32 SI.A-121

BORING NO. 15-7

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ORI FOR	▼-	WATER LEVEL HOURS AFTER COM	PLETIC	ON				>	<b>&gt;</b>	- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID

SHEET 2 / OF 32 , A-123

BORING NO. 15-7

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THEOLS: V WATER LEVEL AT COMPLETION  732  734  735  747  754  775  776  777  778  778  778  778  778	=	-00	1	-	ı		ı			ł	3
TYMBOLS: V WATER LEVEL AT COMPLETION  None Alberty Shalf,  Sha	-	1 3	1	ı	- 1	ŀ	١		ı	-	E
TYMBOLS: V WATER LEVEL AT COMPLETION  None Alberty Shalf,  Sha	-5H	43/-	`	1			1	١	ļ	1	4
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	-			- [			-	ļ	١	-	1
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	-	772		-	- 1	- 1	1		١	1	4
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	=	=					١		1	1	Ä
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	_	1773		-	- 1	- [	1	-	1	1	E
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	•	E		-				İ			7
TYMBOLS: V WATER LEVEL AT COMPLETION  No. A I bany Shak,  Shak,  Shak,  Black, Thinly Laminated,  Soft to Medium Hard,  WI Occ Siltstone Lengrs  and pyrite noduling  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	771.9	[]						1			<b>i</b>
SHALE, Brown Black to  Black, Thinly Laminated,  Soft to Medium Hard,  w/ Occ Siltstone Lenges  and pyrite nodulis  139-  439-  YMBOLS: V WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID		757	Non Albert Shak	-			1		1		7
w/ Occ Silts tone Lengs and pyrite nodulis  138- 138- 138- 138- YMBOLS: ▼ WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID		] ]	CIIA E A ALL						-		3
w/ Occ Silts tone Lengs and pyrite nodulis  138- 138- 138- 138- YMBOLS: ▼ WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID	- - 	<i> 175</i> -]	3 MALES Orown . Olack To	İ		- 1				ļ	= = = = = = = = = = = = = = = = = = = =
w/ Occ Silts tone Lengs and pyrite nodulis  138- 138- 138- 138- YMBOLS: ▼ WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID	5 H	4	Black, Thinly Laminated,		-	.					4
w/ Occ Silts tone Lengs and pyrite nodulis  138- 138- 138- 138- YMBOLS: ▼ WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID	-	1/2	Soft to Medium Hard.								4
YMBOLS: ▼ WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID			and the Silter to I am								4
YMBOLS:   Water level at completion  > Partial loss of drill fluid		Ξ,,,,	out are sells long renges								E
YMBOLS:   Water level at completion  > Partial loss of drill fluid		<b>7</b>	and pyrile noduks							1	<b>E</b>
YMBOLS: V WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID		,,,=									₹
YMBOLS: V WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID	•	/ <i>//</i>				- 1				1	·
YMBOLS: V WATER LEVEL AT COMPLETION >- PARTIAL LOSS OF DRILL FLUID		‡					ı		1		4
YMBOLS:   WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID	•	439				- 1					4
YMBOLS:   WATER LEVEL AT COMPLETION  >- PARTIAL LOSS OF DRILL FLUID		3			-		1	ı			4
YMBOLS:   YMBOLS:   YMATER LEVEL AT COMPLETION  → PARTIAL LOSS OF DRILL FLUID		440		$\perp$	$\perp$		1	$\perp$		L	
WATER LEVEL HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID	YMBOL	s: ▽	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLE	тс	N				,		- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID

SHEET 22 OF 32 SHI A-124

RO		IG NO		Instrumentation Installed								
Project		U.T.P.		Datum for Surface El								
Date:St	art	/ / Complete/ /		1					_			
Location	n N	E	l	l					8807			
Drilling	Ager	icyInspector	z	1				3	2			
	ime		일	_	1			토	5	LABORATORY RESULTS		
Drill M	ypo Iethor		\{ \}	Į	۱_	Œ			F	AND		
Thickne	88 0	f Overburden	Ē	Ī	물		w	8	5	REMARKS		
Depth I	Drilled	I Into Rock	8	6	🗏		2	0	₹			
Total D	enth	of Boring	ו ג	Ē	5	Z.	E 1	S	₫			
Dir. of	Boria	ngVertInclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	를	SAMPLE TYPE	MOISTURE CONTENT	GROUNDWATER-FLUID			
ELEV.		SOIL CLASSIFICATION	1 💆	12	Ĭ	3	3	9	Ĕ			
	DEPTH	SURFACE COVER	<b>├</b> -	╀╾	┞═	-	-	-	۲			
266,9	199	SURFACE COVER	<del>                                     </del>	+	├	t	H	Н	Н			
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‡	J											
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-	415	·	!	1								
SYMBOL	<b>s</b> : 7	WATER LEVEL AT COMPLETION								> - PARTIAL LOSS OF DRILL FLUID		
	~ 1	- WATER LEVEL HOURS AFTER CO	MPLE	TION					>	- TOTAL LOSS OF DRILL FLUID		

SHEET 23 OF 32 & A-125

>> - TOTAL LOSS OF DRILL FLUID

BORING NO. <u>(5-7</u>

		G NO	7	Instrumentation Installed							stalled	
Project			Complete	<del></del>		Dett						=1,
Locatio	1277 10 N	<u></u> (	E			Ī	П			_		
Drillina	Agency						ĺ			9	9	
Driller _		Ins	pector		3					(%)	0	
					Į	풍				E	3	LABORATORY RESULTS
	lethod		5	M	8	阊		Ž	EB	AND		
					8	E	Ĕ	13	릵	8	۲	REMARKS
Total D	epth of	Borina			1 \$	1	1				₹	
Dir. of	Boring_	Vert _	Inclined_	Deg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	<b>SAMPLE NUMBER</b>	SAMPLE TYPE	MOISTURE CONTENT	GROUNDWATER-FLUID LOSS	
ELEV.	DEPT	SOIL	CLASSIFICATION	ON	S	교	RE	3	3	유	ğ	
246,9	l j	S	URFACE COVE	3	Ĺ.,			Ц	_			
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	3	٠			.			1				3
<u> </u>	772				- 1	1				ĺ		4
. 1	4				- 1	- 1						3
- 1	77-				- }			1		1		Ls = Limestone
ſ	•				- 1						1	Dol = Dolomiti
- 9	774			- 1	1						1	Sh = Sharle
- 1	4				- 1							sty = Stylolite
. 19	<del>/</del> 2			-		- 1						Xatalia Constitution
ſ	1										1	01000 (14771/ 15 4
. 4			•		]	-		1				BIP = Redding plans
ľ	4				İ							Mech = Mechanical
<u> </u>	<i>7</i> ,3									1		Break
ſ	4			1							1	Geo = Geologist ]
4	<b>72</b>					l						·
ľ	3				- 1	İ						3
42	=	•		1								‡
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7	m =				].					-		3
MBOLS:		TED I EVE	AT COMPLETIC	NI.					_			- PARTIAL LOSS OF DRILL FLUID

WATER LEVEL \_\_\_ HOURS AFTER COMPLETION

BOF	<b>11</b> 5	IG NO							nstalled
Project .		4, T.P.  Complete		Surfi Datu					
Date:St	urt	Complete						_	
	Acer	vev			İ		١	3	
· Driller		Inspector	Z			H	1	21ء	<b>= 1</b>
Drill T			Ĕ	돐			-	뒮	LABORATORY RESULTS
Drill M	ethod		Š	Ĭ	8			뒭	AND
Thickne	55 0 Tello	f Overburden	88	E	Ĕ	3	핅	8	REMARKS
Total Di	enth	of Boring	ş	3 7	5	교	듸	5	
Dir. of	Boria	ngVertInclinedDeg	JSCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	핔	MOISTURE CONTENT (	
ELEV.	нтаза	SOIL CLASSIFICATION	5	ם	분	8		Ĭ	
276.9	9	SURFACE COVER	ļ		ļ.	Н	4	+	
<b>;</b>	40	·	l	l			1	1	Core is Very Rad
	481	·	•	ļ	l	!		-1	From 495 to 509,5 -
	,,,, :		l					- 1	due to bent Lose
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E	482					$  \  $		.	would not late a per
-	483							-1	-
E '	705						.	- 1	Ward
<b>;</b>			ļ	ĺ					Sample in 4 =: -
F	184		•				- 1		No DEPTH LIEV:
<b>F</b>	تمريرا		l				ł	ŀ	1 497.3 209.6:
E	787		1						497,9 209,0
F	زيرا								Z 500.9 2060 -
E	786	·			l				501.7 705.2
<b>F</b>	487	·	1			П			3 501.9 .05.0 -
E	70/			1					3 <u>501.9</u> .05.0 -
<b>-</b>	486	·		1			ı	- 1	
E :	700	·				П			4 505,4 2015 5068 200,1
E	466	·					/		5067 2007
-	"				l				5 507,3 199.6:
E.	190	·				П		- 1	508.4 198.5
<b>†</b>		Pun in in		l				- 1	6 508.6 195.3
E	79/	Rapin Runs 1.2 and 3 not				1		١	509.5 117.4 =
-	:	determined due to poor			Ì			H	· ·
E	1192	corr control 1		1		H			7 509.9 197.0
5#	"=	core counted by a bent		1		П			3///2 /92//
E	197	COTE DATE!		`		П			8 5/15 1957 =
ļ.	[″:				ŀ	П			8 5/115 19117 -
E	494								•
Ι.	[":								9 5/2.2 1946
2//.9'	415	Start 2 to Core	ŀ		<u> </u>	Ц	$\sqcup$	- 1	
Ė		- Broken Much	•			П			Run 1 min)
E	116	mech (New Albany Shale)				Ø o <sub>Y</sub>	4	1	Cored 4,9 sought
F						y X	Z		Rec 2,9 sumply
ESH.	472	much SHALE, Brown Black to			1	'	1/2		2055 0,0 ) =
204.6	1 :	much Black, Thinly Lamineted			//		8		Tine
2090	198	mich Soft to Medium Hardy Siltstone we occ Silk tone Lease			1				11/10-12/30
E	:	-Broken Mich and pyrite noulshis		1	1:	<b> </b>			
<b>-</b>	499	- Pyrite			12/	<b>∮</b> │			Left 2' of core in
E	:	mech			10				Bot tum of hole
EANIBU.		-Braken Merk WATER LEVEL AT COMPLETION	<u> </u>	1	1	Ш	ш	Ш	> - PARTIAL LOSS OF DRILL FLUID
SYMBOL	۱ :د	- WATER LEVEL HOURS AFTER CO	MPLE	TION	l				>> - TOTAL LOSS OF DRILL FLUID

SHEET 25 OF 32 A-127

>> - TOTAL LOSS OF DRILL FLUID

	NG NO. <u>(5-7</u>			rume face				nstalled
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emion N	E		$\neg$	T		Т	Te	ol .
Hina Ace	ncy		- 1	ı	-	I L		3
wing Age	inspector	_	.	1	1			
		Dec CLASSIFICATION	_	1	Н			
II Type_		——   <del> </del>	:   5	Ì	-		5   6	LABORATORY RESULTS
III Metho		2	ĮĘ	2			2 2	AND
	of Overburden	<u>5</u>	9	ΙĔ			315	REMARKS
	d Into Rock	<b>2</b>	Ę.	≩	NUMBER	وإعا	9   3	
	of Boring	—   ਰ	8		쁴	쁴	5   5	
r. of Bon	ingVertinclined	_Deg _ gg	₹	8	틸	5 9	ءًا وَ	
EV. F	SOIL CLASSIFICATION	Š	BLOWS PER 6-INCH	RECOVERY/ROD	BAMPLE !	319	MOISTURE CONTENT	
	SURFACE COVER	<del>-   -</del>	┽ᆖ	-	H	-	╬	4
			┿	-	Н	+	+	10.2 av 16 1
1500	TMOON	i	Į.			-	1	Run Z Wayed Somp
ا ـ ا	-J+	1		I۱	1	ı	1	Corrd 3.3 2 and 3
0/-	Core spin		ŀ	$1 \mid 1$		1	1	Rec 1.5 100% Arill
- 1 -		1		K	IJ	- 1	ı	LOSSO, O Water Retain
- les	-Mich Spin Fyote	i		[2	١,		1	Time 12:45-13/15
P02-	Prote		1	6/3		- 1	1	11.82 12 (1 -1 1/1)
	· ·			12		1		Left 15 of Corein
5/13	-Siltstone Laminas			1 4				Bottom of hele
	Track		1	Н			1	A The County
:	- Core Loss	- 1		1 1	ł	1		Run 3 Wayed Samp
504_	- Core Loss	1			Ì	Į	1	Cored 6.3 4, 5 and 6
	Core Spin	1	1 1		- 1	ı	1	1 100 100 100
	- Hader Sizz		-		- 1			- F Water Helm
505	Spin Core Loss		1		١		1	Logg 1,35 Water Reluce
	Core Loss	1		1	- 1			Time 13/30- 19/00
P61	-			li	- 1	<i>4</i> 1		1 .
-	- purite	ļ	1.	L I	- [-	4	Ì	Inner barreldicin't
	E avcite nadales	1		М	- 1	ı.l		1
22.7	pyrite pyrite nodales Mech							latch due to bent
- "				$ \cdot $	ľ	اه	1	Core borrel cousin
=	•	]		<i>[</i> ]	. [		1	
208-		į.		80	- 1		1	poor Lore recover
-	- Core Spin Core Loss	- 1		73		- 1		and poor Love
70	11	ł		1	I,	.		contist cont
77/7	-pyrite				ľ			Condition Rods pulled
7	-Corc Spin			$\dashv$	.	į	1	Run 4 Core borre
70	- prolts Mach	-	1 1		П	1		Kun 7 Core borre
		- 1	1 1	- 1	-	-		Cored 5,3 fixed
-	-pyrite	ļ	1 1	ł	İ	1	1	
m-		Ī	1 1		-	ı	1	Rec 5.3
1 4	- Mech		1 1	0		1	1	L095 0.0
1		`	1 1	11	1			
<i>522</i> –	- mech	İ	1 1	$\lfloor \cdot  floor$				Time 11:45-12:10
_   ∃	- prite and filts toar Lominar		1 1	7	7		П	
7/3-				1/2	,			100% Doill water 1stal
:1 =	-Mech		1	P				
7 3	_19/1/2	<del>.  </del>		3	rl			in Shole, Drill water
57/-	Jefferson ville Lines	tone		<b>N</b> :	[]			Losges & tarted to occur
4	=5+v		1 1	- 14	4	1		at end of ran in
=	Zmach		L			1		Limis Tone
1775	Allens Li don . 1	. 1		- 1		1		Run 5
1 3	- Alf open Hydro Carbons		1 1	.	1	1	1 1	Cored 10,3
776-3	-BIP open present in JeffersonvillegLs					1	1	Arc 10,3
"7	Jeffirsonville 1.	. }			ĺ			
4	_Sh Laniar B/POpen	'		6	1	1		LOS 5 0.0
` <del> </del> 777-‡	- Very Acrillana		·	0	-		ı	T
. [" ±		PAZ				1		Tine 13:50
2 ]	-AIPSh 0.03 O.p. Th Ele			1	1			12:30-13:50
578- <del>-</del>	5/34 /93	7		14				
1	2127	<u> </u>	1 1					
<b>L</b> , ‡	-Sh Laminaz	<b>-</b>   ·		2	1			•
779-	-Sh Laminas	]	[	19	1			•
1 3	51 0.01	1	1	1				
, j-								
20F	C+ 5h 0.01					]		Opillwater Return

SHEET 2/2 OF 3Z SH A-128

		IG NO. <u>(5-7</u>		instr Surf						stalled
Project		/ / Complete/ /		Det						51.
Date:St	<b>art</b>	Complete			T	J- 1	_		_	
		E		[	l	ł	ł	ı	1.083	
Drilling	Ager	1CY	l _	1	1	ł		3	12	
Driller _		Inspector	USCS CLASSIFICATION	ł		ľ		٦	1₽	
Drill T	ype_		Ě	<b>X</b>	1	ł	ļ	MOISTURE CONTENT	FLUID	LABORATORY RESULTS
Drill M	ethod	1	5	12	١	NUMBER	l	ΙE	14	AND
Thickne	33 0	f Overburden	⊑	J	Ιğ	۱Ē	w	18	ATER-	REMARKS
		into Rock	8	g	I٤	13	2	0	7	, included the
•		of Boring	1 3	1 2	15	Z	<u> -</u>	분	ĭ	
	epui Dod	ngVertInclinedDeg	0	2	₹	۲	۲	12	볼	
		N	8	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE	닄	翼	g	
ELEV.	E	SOIL CLASSIFICATION	S	ᆵ		15	15	ĭĭ	뚱	
1864	GE D	SURFACE COVER	<del></del>	+-	-	۳	۳	┪	H	
MWI	520			╫	╁	┢	┰	┝	Н	
•	320	L MAIONTS (MORT . JAN MEDDE) (M	[ ·	1	l	l	ı	1	Н	
•	:	Lithray, Hard, Fossifriens,	i	1	1	1	ı		П	
- '	52/-	-BIP Porong W/Hydrocarbon	ł	i i	i		ı		П	
	-		i	1	1	l	ł		Н	
45	L -	-BIPSh O.Pl Sh Lominaz		1	1	1	l	ļ	H	
<i>-</i>	522	- Very agrilled & Black perons		1.	1	1	1			•
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•	آجرا	Louisville Linestonz	l	1	1	1	ı	Ī		
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-	93/-	<u>,                                     </u>			1/1	8		1	1	
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	<u> </u>	WATER LEVEL AT COMPLETION					-			- PARTIAL LOSS OF DRILL FE

SHEET 27 OF 32 A-129

BORING NO. <u>(5-7</u>

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Project				Surf. Detu						51.
Date:St Locatio				<del></del>	<u> </u>	Ť	Ť	Ē	_	
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hickne	<b>133</b> (	of Overburden	<u> </u>	•	12		삝	١Ā	벁	REMARKS
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otal D	eoth	of Boring	<b>F</b>	-	5		-	ᄩ	2	
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			USCS CLASSIFICATION	BLOWS PER	RECOVERY/ROD	Į₹	Į₹	ō		
LEV.	DEPTH	SOIL CLASSIFICATION	-	8	<u>«</u>	8	SAMPLE TYPE	13	a	
16.4	قا	SURFACE COVER			L_	<u> </u>	╙	<u> </u>	Ш	
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	-	-Mesh		1 1						
	54/-	-Mrch								
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	154Z-	- BIP Open				l				
:43	•					ŀŀ			l	
	372	Porous to Very Porous Zone				ii				
	-ر, ر	-AIP Open								
-5	:	Porous to Very Porous Zone -AIP Open Solution Ospth Elev								
-5	544	-Vu; <u>542.6 164.3</u> -54, 5526 1543								
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ļ	575-	- BIP SOIN TIUM		i			-			
ĺ		- RIP Open w/ xstoll  RIP Open w/ xstoll  Sty Popen Ventical Fracture		ŀ	_				t	Run 8
}		Sty Vestical Fration								
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Į	7	- BIP. Vertical Fracture	1			ļ	21		ŀ	Time 7:30-8:30
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- 1.	_1	Sty Sh Laminas	- 1		11		-	ļ	1	•
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Ρ.	74	5H Lamines	- 1	1.	V		1	1		
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_	<del>58-</del> †	Dapth Elec	- 1	l I	۲,	.				
r.	~∃	cont 144.	- 1	- 11	Vd.					Time 9:10-9:37
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2	77	561,9 145,0		- 1	19			-		20% Drill motor Ret.
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_	‡,,	off .	. [		- 1	1	-	ł	ļ	Has Oder
ABOLS:	<u> 207</u>	WATER LEVEL AT COMPLETION				1	1		L	- PARTIAL LOSS OF DRILL

SHEET 25 OF 32 SH A-130

BORING NO. 65 7

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	ype_		ATI	푱		_		孟		LABORATORY RESULTS
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		/ Overburden	2		Ĕ		Ē	8	F	REMARKS
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- 145.0'	777	Lare Spin Ch p p2'			1					<u>:</u>
E	106	Shloming				ĺ				:
E		Shloming + Shloming Moch			•					:
F	563	5ty 5h 0.01'		l						7
F	:									•
- 25	24-	- Sh Laminay Sh Lamina + Mech				1				<del>-</del>
F	:	- ShLominor Mech						1		•
F	2/5	574 6/1/				l	15			<u>-</u>
E	$\omega$ -:	Shilaminat 0:03 apart				١.	14			:
E		-5 N M-14		•	<u> </u>	ļ	12			•
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ŧ	:	BIP OPTA					1	ŀ		Cover 10,3
Ė.	56 Z	- 5h 0.041'							П	Rec 10,0 -
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E	sze.	Vertical Fracture Open							ł	Loss 0,3
Ė		Sty Open Open								Time :
<b>F</b>	100	1								4155-10135
F	564	- BIP Upin				┡	ľ			-
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E	170	- BIPODEA				0		Ì		=
Ė	: 1	Love Spin Sho.04'				Х				<u>:</u>
<u>L</u>	57/-	Vus core 2055 0,2			70	5	1		П	Some Sections of -
ļ.	:	\					i			•
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E,		Esh Core Spin Oil Core Loss				<b>\</b>				:
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‡	[":	- Sty Open								·
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E	′ <b>′</b> =	- Sty Mech			$\vdash$					Run 11 :
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<b>F</b> .	2//دا				0					lored 10,1
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ļ .	578-	<u> </u>					H			Luss 0.0 -
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SYMBOL		WATER LEVEL AT COMPLETION				_				- PARTIAL LOSS OF DRILL FLUID

SHEET 29 OF 32 A-131

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roject	U. T.P.	<del></del>	_	Surte Detur						27
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rilge	Inspector	<u>}</u>	중		ļ		l	9	₽	
rill Type_			Ĕ	Ŧ.				되	3	LABORATORY RESULTS
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hickness o	f Overburden	!	Ē	Ī	9			٤I	ᇤ	REMARKS
	I into Rock		2	5	E	3	2	5	Y	REMARKS
otal Depth			5	<u> </u>		Z		쀧	₹	
	ngVertinclined	1Deg	2	2	ΣI			21	킭	•
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERYMOD	Ы	31		릵	
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_   <del>]</del>	- Core Spin Sh 0.0:	ر <i>ح</i>			- 1	ı		1	Т	
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1 7	- Sh Lamines Mark	· · · · ·	1	Γ	7	-			Γ	Run 12
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>> - TOTAL LOSS OF DRILL FLUID

BORING NO. <u>25-7</u>

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		Inspector	<u> </u>	JBCS CLABSIFICATION	1				۔ ات	
	pe		I	Ĕ	#	l		SAMPLE TYPE	MOISTURE CONTENT	LABORATORY RESULTS
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SHEET 3/ OF 32, A-133

BORING NO. 25-7

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		Overburden		2	Ĕ		TYPE	8	E	REMARKS
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YMBOL	s: V	WATER LEVEL AT COMPLETION							. :	- PARTIAL LOSS OF DRILL FLUID

SHEET 32 OF 32 SI A-134

BORING NO.

PROJECT NAME

DATE: Dec. 10, 92

5-17

CORE BORING NO. PAGE (	FEAVARS												sk: slightly rough.	7			2 8m	,				MB (vertical break)		Vertical st.
	WEATHERING		ΩΛ	5~	цh	11	И	S:W		KX	IJ	``	u	,	,	10	•	•	`		Uh		u,	ۍ ح د
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HOLE _	EER	496.3							. 506.3											7/5		- 508		- 510
. TOP OF BOLK	СВТИ	491.6-	492.15	494.05	3-464	494.55	494.6	495	446.3	496.1	496.4	497.4	498.3	499.9	501	501.55	502.7	503.95	505	506.3-	506.73	506-72	P-808	509 -
ELEV.	JON CA	RUNI	-	2	3	7	٧	9	RUN 2		~ 4-1	35	7	ک	7	7	8	4	0)	Ru4 3		જ	بخ	4

Dec. 13,92

DATE:

CSZ

Plakes 3 walce PAGE 1025 HEMARICS ۱۰ النام ۱۰ مدي ومميع shake Shalle 1ens CORE BORING NO Shale Fossils MB WEATHERING 3 2 35 S 20 C S 5 calcite 9west 2 calcite 3/80 MINEUM. calc. 912 Ş Ş 97 ν **MOLEONO** No १ Ş Z S " ٠.1 000 Open Open Open TIGHTMESS Open 4 mt 3 mt W PROJECT NAME Polisha SIMY R ASPERITY 5 12 SR 5m 512 SR 23 Ø B 8 Ø Q B Ø OFFENTATION ° °d (5) °O 0 •0 s S S ° ·d 50 5 ိ ° 0 Ę 3 C Q  $\mathcal{C}$ ۵ đ S J đ đ a 9 ط D 536 236 745ă 5/5.22 531.88 543.85 530.65 540.35 543.9 514.4 540.75 226 526.7 539.7 540 511.7 536 538 3/6 543 5/4 145 RUN 4 RUN5 RUN G NO. d 3 တ 0 'n 7 J S A-136

ELEV. TOP OF BOLE

PROJECT NAME

Dec. 10,92 CORE BORING NO. DATE:

CS-1 Sec. 25 Scacalcite mudic Seam 1625 **FEMARICS** shale Shalle Shalle shale MB W.B 8 " 0 EWED Un WAS W WEWNERING Z 277 SC 77  $c_n$ J N 3 2~ 35 35 3 3 3 •• Ŋ MENEUM. Z واد ٥ Ş Ş ટ્ટ \*\* \*\* 1 COODCINCK <u>ه</u>. ٥ S Ž 11 4 " Open THEATHERS 200 7 24 mt + \* 7 4 tu u W Very R ASPERITY SR SR 512 SR Q SR Q Q 2 8 \* 11 DFIENTATION 150 12, 00 5 ०व 0 0 ô ٥ 0 " 5 F 2  $\sigma$ व 0 2 S V S ٦ 2 2 ٥ S つ Ş ú S 質質 556 BEY. ELEV. TOP OF BOLE 556 1566 548.75 556.05 552.45 54.43 548.85 550.8 553.95 547.8 549.9 545.75 553.7 545.53 547.75 551.4 547.65 553.3 547 557 5.58 246 552 **E** 549 Rua 7 Run 8 걸 8 (L) 9 13 17 14 1 7 1 18 B 3 6 4 1 ø A-137

43

Dec.

DATE:

Seny 4125.4 CSL がな PAGE 1645 HEMANAGE الا CORE BORING NO. 543 \eus 912 وسري shale shale shale shale Shabe Shabe علىاها WEATHERING <mark>ک</mark> 3 C 5 5 ろう 5 4 u ca/c. MENERAL. ર્શ્ટ 2 Calc Š **DEED CHOOK** ž Š " TIGHTIMESS Open  $\mu$ mt 1 a 0 Z 10 0 d 0 " PROJECT NAME ASPERITY 5R 3 2 8 Q 엗 DRIENTICH S .07 100 0 601 9 0 ° 20 0 ° 0 0 ٥ 0 E 2 Q 2 2 S  $\mathcal{C}$ Q 2 2 Q S 2 2 2 S S S Ś 574 ELEV. TOP OF BOLE BE 569.35 570.3 560.85 564.85 565.95 562.5 5.69.7 571.4 572.4 573.4 565.5 565.14 568.3 568.6 573.1 565.6 558.7 566.2 567.7 559 573 566 567 0 F S RIN 9 7 00 S 0 7 7 1 0 9 A-138

Dec 14, 92 DATE:

Broken - Grushed rock & pylite Shale lens , Vertical Warit S Joint @ Shale - L.S. Interface 41,4 3 CORE BORING NO. C.S. PAGE grante lens (3/4 shalle & white Shale HEMANES Vens lews calcite Pilm Shale lens \* This shale Shalls. WEATHERING 2 35 3 35 25 S 00 altite Prit MENEUM. <u>किरो</u> S 2 Z Nο DESCRIPTION ž No THEFITHESS 200 30 机 mt \* 0 1 PROJECT NAME ASPERTY 3R **5**2 \* **OPIENTATION** 30° 55° 45° 80% 300 0 9 00 0 50 0 ဝိ 20 Ĕ C M Q 2 J 3 8 v Q 5 V 587.8 584 594 BEX 584+ 574-95 583 .4 583.35 585-8 586.3 576.3 588.4 P-982 579.3 583.6 577.7 579.3 584.A HE-00 587 587 589 574 Ru 10 JOH NO. 3 7 Ø 1 Ø

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Calaite

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V

ELEV. TOP OF BOLK

47

Dec.

DATE:

PROJECT NAME

Call City & trace of parity ~/ calcite (v. 1/2) filling CORE BORING NO. CS-1 Pyrite residue & Shell & REMANAGE 3 shale lens TOCK Whin 9tz, shalle Shalle Shulle Crushed المحر WEATHERING 2 2 Ş 2 δŠ 5 3 2 **SV** 5W S S " 3 Pyrite Pyrite MENERAL-IZATION Š Ş 912 No CHECKTON Ş Ş TIGHTHESS open open Mt mt T mt mt 00 0 0 ASPERTY 56 Q Ø 8 DREDATION 400 450 150 45° 300 , ק 300 0, . 07 50 0 0 0, 0 Ę  $\mathcal{C}$ S J Q 0 0 a 0 2 Q S 9 2 8 403 BEX 597.15 622.45 6.00.9 593.05 596.4 598.3 593.9 396.5 599.6 594.95 595.5 623.3 595.2 594.5 594.7 601.7 593.3 594 1-965 600.1 **E** Rivia ¥0¥ 15 3 h A-140

ELEV.

TION OF HOLE

PROJECT NAME

ELEV. TOP OF BOLE

CORE BORING NO. CS-1

shale tens PAGE lens shalle PEMARES Crushed shale 8 WEATHERING SW S کر ک 3 ç MENEUM. ટ્ર δ DOMESTICAL Š Ş TIGHTNESS mt tu mt mt mt ta 0 0 0 d " 0 0 ASPERTY 5m SR SR Ø 2 007 **OPIENTATION** 0  $\alpha$ 50 5 رور ° 0 E V 2 ط D d  $\mathcal{C}$ n ے S ٥ P S 4 9 2 2 615.5 609 EP 612.45 612.95 614.9 615.25 625-75 607.45 613.75 614.3 614.55 614.2 614.8 605.55 5.69.7 625.65 4. 909 613.3 607.3 6.115 614.7 611.2 6//.8 83 ¥E-80 403 608 12 NID RUN 13 9 7 7 1 8 2 1 J A-141

4

3 CORE BORING NO. C5-1 PAGE DATE: U.C. lem? Interface of 1.5. & HEMARICS Shele 4 mm WEATHERING NO 25 3 S S 2 7 <del>کر</del> ک \* Ş MINEW. ςŅ <u>ر</u> γ ر 2 2 -modo TREATMESS Z mt mt 0 0 PROJECT NAME ASPERTY 52 32 かべ SR 5R B 22 4 DPIENTXTION 300 2 0 150 20 ô 0 1 9 Ċ. G 2 0 C C σ 5 Q 힉 a M Q 質し 630 5 625.5 630.5 ELEV. TOP OF BOLE EE Both @ 625.5 625.5 615.5 621.3 621.75 629. 4 621.05 619.25 4.779 628. 2 8.877 615.6 6/6.05 C16.7 6.675 617.1 6/8 R1419 Ruxte 7 امن 7 0 A-142

DATE: Dec. 22.92

PROJECT MANE UTP

ELEV. TOP UP HOLE

CCRE BORING NO. C5-2.

w/ calcite cementing w/calc. residue healed @ gray shake unweathered HEMARICS then broken Top wall Crertical 511-511.9 LM. mB WEATHERING Si 2 3 2 3 calc. Ş MINERAL-IZATION Calc. ې • Z CHEDICTION مح OZ TIGHTHESS E t w ¥ Y VM 0 0 53 Sy ASPERTY SS è 83 517 0 þ d 10 ō 2 OPPENDATION 900 ° 。 0 0 E ٥ م " " " ۵ 1 異なる 514.2 aB 515.5 505.4 BEK 511.0-511.35 508.55 505.4-506.25 Timber St. 509.25 510.C 504.85 505.55 502.75 503.85 507.3 511.9 507.9 505.9 512.1 506.6 503.3 501.3 502.1 507 520.8 500 Ru 2 Run AC. A-143

PROJECT NAME

ELEV. TOP OF BOLE

CORE BORING NO. DATE:

5,26 CS-2 of filled w/ warse sand shalle secum Shake HEMAPHICS rock broken rock 3 Him Shale Broken Contact · , WEATHERING 3 3 3 3 5 77 2 " Pirik pyrite Parite pyrite pyrite 5، 70 MINEW. 2 Š OPEDATION Ş 405 70 CV No " 4 TIGHTNESS ŧ F \* 53 ASPERITY 57 SR 8 83 2 م OPPENTATION اتم ، <u>°</u> 0 0 ° O 00 20 ° ွိ 11 5 C 1 Q. **၁** Q. つ 5 2 つ 9 ٥. 2 S Q. 3 n 535.3 525.5 **B**EX 526.9 527.45 522.85 524.35 527.55 517.65 5.025 522.2 525.5 515-15 515.45 519.3 521-3 5.8.3 515.5 523.4 5/6.6 512.65 513.2 514.4 513.4 513.5 Rus 4 Ruo 3 A-144

PROJECT NAME

5-50 DATE:

- Croded PAGE REMARKS CORE BORING NO. Very V4393 8055:15 रिक्वर mB WEATHERING 32 ヹ 35 3 3 3 3 3 5 Z 912 9 62. MINERAL. N.S .Z • CONDICTION c Š •/ THEHTHESS ナダ z 7 1 0 0 9 0 0 0 0 0 ASPERITY 5 \$2 2 38 OPPENDATION 9 50 150 00/ .57 50 ° 0 0 ħ E ٥ 2 2 > S ၁ ၁ フ ٦  $\supset$ 리 つ 7 3 545.8 556 RLEV. TOP OF BOLK 548.53 548.73 548.9 549.6 547.3 547.35 547.85 535.84 550.7 545.8-544.15 544.65 747.4 546.5 550.1 537.3 Pin 6 A DE

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A-145

552.28 552.53 ž

5 S

DATE:

Mach C5-2 Vuegay bottom REMARKS Sea. Sch CORE BORING NO. croded Shalle Shale WEATHERING 3 2 3 5.5 S 3 3 <u>۲</u> 3 3 1 3 11 cale. G/c. LENEW. ٥ Š с Z CONDICTION ς V ろり TREMINESS さ 1 z t # 0 • 0 0 PROJECT NAME ASPERITY \$ 5 R Q sR Q SP. Q Q હ كرا 150 DPREMIMEN 18 c 0 150 ŝ 15, 15, ° Oi ? O ŝ e O 0 0 っ つ つ  $\mathcal{Z}$ つ à S 5 2 7 S C V v 0 ·D フ 275 BE ELAV. TOP OF BOLK 565.15 564.15 564.8 565.7 9.295 564.6 560.53 562.25 543.5 555.85 561.55 563.3 558.8 559.5 561.8 556.9 1.095 554.85 555.3 554.9 556.4 553.4 556 **E** 554 Rus 1 E de A-146

CCRE BORING NO. CS-2 DATE:

CCRE BORING NO. PAGE 5	SHARK		2 min thick shalle seam	\ mm \ ; ; mm \	*		sinalle scam		eroded & broken to Flakes	eroàcd			4 mm shake seam				-							7 (7,000)	)	
	WS/THERMO		מי	*	"	SW	3	*	3	,	٧٥	*	CC	*	١	<b>ک</b> ده	•	٥	3	nn	»			On	S.~	,
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PROJECT MAME	ASPERTY		22	"	"	5.2	B	4	"	"	u	sR	5m	<b>5</b> R	"	"	R	"	,	"	5R			śm	"	8
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DATE:

TOP OF BOLE	HOLE _			茁	PROJECT: MANE	<b>35</b>				CCRE BORING NO. C5-2
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PROJECT NAME ELEV. TOP UF BOLK

いいい くいつ Shack Lews いない Smalle 1025 HEMARKS shalle shalle 222 shabe } 7 Ŋ WEATHERING C 3,5 CO 35 3 3 5 35 3 3 #2 Ş 418. 20 KINGW. Ş • ςy " " CONTRACTION ر د <u>5</u> • 4 TREATMESS + 111 mt At J W 0 ٥ 0 0 " • ASPERTY 36 5R 24 8 28 Q SR OPPENDATION 400 (50 0 0 ô 50 50 0,0 .01 S 'n 1 ۵ 0 Э Ŋ 2 S ٦ 2 つ Ŋ 8 4 'n u 606.3 BEX 623.3 594.44 624-43 605.5 600.7 54.809 604.3 4.269 605.7 596.05 597.15 600.3 590.35 540.4 594.4 595.3 598-3 602-3 593.7 60,6 602 Run 11 A Ch A-149

DATE:

CORE BORING NO. CS-2

CORE BORING NO. CS-2 DATE:

PAGE	PEMARROS									ومال	shalle seam (1mm)			shake seam (1mm)					shake scan (2mm)			Shake som (1 mm)	2 8	.,		
	WEATHERING		sω	,,	"	u	7	•	5√		*	Un	•	*	4	*	٠	*	•	\$	"			,,		
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	ASPERITY		SR	,	4	*	5 m	sR	*	8	R	5 R	•	•	R	5 m	52	3	+	4	v	w5	5R	Sm		
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	JOHT	R. 0.13										A	\-1 <b>:</b>	50												

PROJECT NAME

ELEV. TOP UP HOLE

ELEV. TOP OF BOLE

PROJECT NAME

CCRE BORING NO. C.S.-2.

	FEMARG	-	2 mm shalk vein	6 mm 8		shalle vien		green colorization				shale seam		shalle seam								shalle seam				
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DATE: Dec. 24, 92

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14/61/54

DATE: 1200 29-30 - 1992

CCRE BORING NO. C.S.-3-

JOINT CLASSIFICATION LOG

PROJECT NAME

ELEV. TOP OF BOLE

Crushed rock Colored HEMARICS Ú Green mB WEATHERING 3 ટ 3 Š  $\mathcal{S}\mathcal{E}$ 38 3 4 // 3 5 1 5 5 30 20 Jyrike, 50 20 20 40 ر ج Ş 50 MENERAL. 1/ 1/ 1 1 d 4,0 ٥ ک 5 50 20 50 50 365 50 CONDICTION *٥* نـــ 5 1 1 90 CPOP 9 OP TIBHTHESS 00 mt mt nt06 mŤ m m÷ tw ÓЮ m 1 Sm SB SR ASPERITY 5R SR 5m SE 8 ムぶ Q 1 1  $\tilde{\mathcal{Q}}$ ã 0 DEFENDATION ŝ 40, 0 150 0 001 1001 ô (0) ô • ô nin 5 1 0 1 E 0 Q σ  $\mathcal{L}$ S 9 20 Q  $\supset$  $\mathcal{C}$ 2 Q 0 521-12+521-82 + 524.8 EEK 520.55 514.05 515.5 517.75 521.67 5/8.65 519.55 519:75 5:125 517.05 513.55 517.52 5/8.4 519.3 510.45 511.95 528.55 511.15 509.4 510.6 211.2 214 51 HLABO € A-153 A CH

PROJECT MAME

ELEV. TOP OF BOLE

n shale vein HEMOTICS 3 \*\*\* Shale > WEATHERING 2 いつ *S*: 2 W 3 Pyrite MINERAL-IZATION γ° 3 Ş S S • 8 COORTICAL Ş کم TREATMESS Ĭ m tu 0 0 0 0 ASPERTY 5/3 Sm SM 35 SR Q DREATHON ° 30° ° ° 20 ° đ 2 ۵ P ٥ 7  $\boldsymbol{c}$ σ ۵ 534.3 + 544.3 524 - 534.3 ă 536.32 529.85 523.75 522.45 527.3 272.6 526.2 538.2 7.475 525.4 523.6 521.9 HE-000 Ring Run 5 Rune A-154

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DATE:

М C.S. PAGE CORE BORING NO. PROJECT NAME BLAV. TOP OF BOLE

next o.1 broken rounded rock. shale ( ۲سمام دع shale vein REMARKS Coloring Porons V49364 8055115 Vugged Vugged Vugged 2 mm 1 mm Very W B M B WEATHERING S ن د S C 2 S 7 00 SW S 33 S W \*\* Ν̈́ MINEMA 763 No <u>Σ</u> ύ δ CONDICTION ٥ 20 No 5 3 THEFTINESS Z # m m+ ž T 9 0 Q 0 0 Q 11 " ASPERITY 53 52 SR 々 5,5 20 X " Z Q Q **OPECATION** 300 0 101 • , O ° 20.  $\bar{x}$ 0 • ° 7 °2 2 2 ۵ ۵ ٥ ٥ 2 2 م 7  $\supset$  $\supset$ ۵ ٩ 0 c $\supset$ 554.5 EFX 553.17 552.65 550.05 553.45 548.15 552.35 545.9 545.4 246. J 546.63 541.C 549.15 2-645 550.3 551.7 544.5 544.9 546.9 547.12 545.2 545.3 544.3 1.155 HE BO Run6 A A A-155

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ELEV.	7. TOP OF BOLE	HOLL			<b>P</b> 4	PROJECT MANE					CORE BURLING NO. PAGE 5
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DATE:

C8-3 CCRE BORING NO. PROJECT NAME

( N~2969 ) HEMARICS くさく " crystals Shale WEATHERING 3 5W 52 3 Un 3 3 00 \* crystl. જ δ MINERM. Ž 912. 915. જ Š CONDICTION Ş 20 S THEHETHESS THE Ŧ ŧ Ė 0 0 9 E 00 1 9 " ASPENTY 200 sR Q 5/2 2 arphiOPPENTATION 35. 100 120 0 25 30° 0 15. (0) 300 0 ° ,01 Ę. 2 ۵  $\mathcal{C}$ : 2/2  $\sigma$ 9 S 2 ၁ ٩ 复数年 BE ELET. TOP OF BOLE 563.15 563.4 559.65 560.55 541.95 563.7 364.1 559.35 562.3 556.5 558.8 559.3 561.4 561.9 562.7 557.6 560.1 561 557 F 가 A-157

CCRE BORING NO. C5-3 PAGE 7	DEMARK			1 mm shalle vein	,	trace of Pyrite (Ungged)	4 mm shale vein									Vagged walls	-	Vugged walks	2 mm shale vein			some shale			
	WEATHERING			mosi. w	ů	رب و 1	"	2	<i>ک</i> :ک	Ün	3 2	<u>ر</u> د	"	,	۸	.3	"	· ·	*	"	,	\m. \			
	MINEWL. (ZATION		Pyrite	οN	γ	Prite	Š	٥	"	"	1	<b>V</b>	"	ţ,	``	"	"	"	"		"	"			
	ONDATION		No	,	1	,	"	,,	"	1	7	"	"	"	"	~	"	"	"	<i>'</i> II	"	,			
	TREATMESS		00	OP	- tu	~	"	*	•	,	"	7	tw	,	1	,	1	*	"	"	"	1 cm			
PROJECT NAME	ASSERTY		R	Sm	58	"	Sm	SR	7		sm	512	"	Sm	R	R	58	"	У	5	v	VR			
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	JOSHT PER								•								<del>,</del>		·	1			 ı—-		Γ-
ZOLE _	EEK	- 574																							
TOP OF BOLE	нива	564.9	564.65	564.8	564.95	565.7	1.358	567.15	547.75	567.95	2.875	27.895	564.02	569.47	5.8.8%	564.9	510.6	112	571.65	515.15	572.65	573.15		·	
בוש	JOHNT	Ru 8	-									A-1	58												

C5-3 CORE BORING NO. DATE:

ELZV.	. TOP OF HOLE	HOLE			<b>14</b>	PROJECT NAME	300			·	CORE BORING NO. C5-3 PAGE 8
JOHT NO.	HLABO	BEK	JOHN PER	TYPE	ORIENTATION	ASPERTY	TOPHINESS	CONDICTION	MENERAL. EXTOR	WEATHERING	REMARKS
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	4.515		<b>,</b>	n	. "	,	. ,	"	*	"	
	576			~	153	В	0	8	,	ل کر	left wall shale, Right Lis.
	576.35			Ь	53	5R	t pr1	,		ý	
	517.2			Ь	15°		Ş	•	``		
	577.77			٥	35°	"	,	11	"	"	
	578.1			၁	153	`	0	*	2	3	Some shake
	4.872			Ь	0,	"	0	11	·	,	
	578.55			0	°,	R	0	"	"	"	
	519.05			9	,01	sA	l +w	1	"	j	
	579.5			5	30°	R	,		¥	,	•
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	580.8			Ь	,0	۲	`	"	,,	,,	
	581.35			ဂ	01	``	,	"	"	*	
	-5.185			ŋ	30°	`	,		. "	"	
	581.85			<u>ک</u>	0 3	"	0	"	"	00	quartz lens Joinhed
P., 10	5824	583.9									at its middle
	582.4			0	ر ۵۱	5,2	Ī	٥٧	مکم	5 S	
	582.95			0	15.	"	"	*	"	"	
	583.55			5		В	`	`	,	5 2	
	583.8			Ú	20°	,	ï	•	`	,	

PROJECT NAME

ELEV. TOP UF HOLK

Shulle lens 1.31 fine fraquents 2 mm strick stricke vein いけい といり ٠ ا ا とはつ PAGE Sherke Shade snede Shale HEMORICS snake 3 mm thick という 7 mm 7 1 d mm WEATHERING SJ C C C N Sw Š 35 S z 3 S MINEUM. Ş 2 **MOLLEY DATA** 20 S THEFTHESS te È tw mt mt 0 0 ASPERITY 5m 53 23 SA S 8 5,0 d d Q d d Q Q \* DESCRIPTION 300 0 20. 150 15° 30. 15. 400 , 2 10' 15 1%, ° .0 ° ō ° E 2 2 ၁ ۵ ٩ S S 2 2 2 Ÿ 4 S  $\boldsymbol{c}$ J c601.5 +624.3 EEK 594 595.75 596.85 597.65 599.65 600.02 601.5 583.4 541.85 593.55 588.25 584.45 586.75 4.009 584.7 5.985 592.2 544.6 597.3 247.7 E BO 294 593 599 109 A-160 Rio 11 F 및

65-3

CORE BORING NO.

CORE BORING NO. PROJECT NAME ELEV. TOP OF BOLK

C S- 3 PAGE くなう (243) FEMORES shale Rock eroded Crushed eroded 1 N WEATHERING 2 Se 00 ີ້ \* -1 W " \*\* MINERAL-IZATION ر د 5 ک ن 44. CONDICTION S 5 5 11 " THE-MINESS tim 300 mt mtmt mt 0 0 0 W. 0 0 0 " ASPERITY SR VR SR 22 Ø • X MOLLDAMORA 0 400 250 453 150 40° 40, 30° 12 ° 0 0 ų, ,, 1 0 D Q S S S ŝ 0 al S 2 ٥ 2 ၁ ð S a  $\supset$ 9 9 602.6 604.2 4 614.3 ğ 54.209 611.15 52-215 413.85 603.4 612.05 602.55. 502-7 607.05 209.6 608.15 22.01 6.019 601.85 503.5 2.309 7.509 607.3 608.7 603.4 605.1 **E** 613 € A-161 

Shalle lens separated on Stam Seam Broken by shilling PAGE shale shalle REMARKS CORE BORING NO. Paces Shalle 2 mm 2 mm mB both WEATHERING ຊ z ຊ້ Z C Ş MNEW. ş Ş λs \* CHECKTION 20 cγ Š Ş 4 ı, u -TIGHTHESS mtmt m+ 0 " 0 0 " PROJECT NAME ASPERITY Sm 5m 23 23 Sm SR SB 5m SR Id d 1,5 ОРИЕНТИТОВ 15° 20° 200 352 0 5 252 (n *i0*i o Vi 25° ሌ 00 ° O 'n Æ つ ٥ ٥ ٥ \*/ ۵| σ  $\mathcal{C}$ 4 ۵ 0 2 J 11 626-1-636-3 626. 614.3 +C14.C 717 EEX ELEV. TOP OF BOLE 630 . 72 631.42 59.279 620.55 615.75 2.627 615.05 615.55 5.425 625.3 614.3 8.4.2 615.5 6/6.55 618.9 615.7 9.419 919 Ru 14 S/ c A-162 NC.

DATE:

C5-3

DATE:

PROJECT NAME

c s-s Page Vens CORE BORING NO. shale WEATHERING  $c_2$ MENEUM. No CONDICTION ٥ TIGHTINESS 1+-mt ASPERTY Q OPPENDATION ° S 風氣 636.3 + 639.45 ELEV. TOP OF HOLK EEK 638.1 **E69** R:017 JOHN THE | A-163

PROJECT NAME UTP

ELEV. TOP OF BOLE

CORE BORING NO. C5-4

DATE: Dec. 15 ,42

clay filling W/ fine conshed rock side walt 40 REMARKS ఞ lens ودح ولعج لعدا W 8 mB MM Pyrite clay 3 WEATHERING 5 3: 5 5~ · Š MINERAL. ટ્ DESCRIPTION 20 2 200 Open THEFTHESS 000 open 200 0 000 刻 0 \* <del>z</del> 3 Polished Polished ASSESSED Sm Sm अ 11 OPERITOR 1.5 9 ° 0 Ø <u>ل</u> ے 2 ٩ 9 9. 666 505.3 499.9 515.3 E.C. 499-5-505.3 -499.2 -499.7-502.25 503.05 505.35 499.4 500.95 506.15 503.85 505.33 503.4 596.3 506.85 507.5 F005 501.4 503.7 505.9 507.3 504.6 506.7 500 Run 2 17.7 2 12 A-164 4 7 7

PROJECT NAME ELEV. TOP OF BOLE

CORE BORING NO. C5-4

PAGE 6	PEMATRS						Parite lens at top wall	mB		mB		<b>™</b> B				Vace of Darite	,	11			L.S. Stratum starts at	Icus between shalle &	l i		shalle seem
1	WEATHERING	νn	•	•	4	¥	ş								ריח	,,	"	\\	,,	,				5~	,
	MINERAL: IZATION	%	•	``	,	"	"		"		,				Nο	**	٠,	٧,	NI.					٥٧	**
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	JOHN T													<b></b>									, <u> </u>	<b>,</b>	
	PEK													525.3						-					
	DBTN	509.35	510.3	8.015	511.2	4.515	512.7	513.4	513.9	HIS	1.415	514.85		515.3-	5.515	2.715	5.115	5.8.2	518.9	5/9.8				520-85	521.3
	LCINT.	cı	" "	1,2	13	61	15		9/		L'A	-16	5	Run 3	-	2	3	4	5	7				7	80

(5, of shale Eraded J 912. Crastals C5-4 PAGE k~> <u>ز</u> نه: lens / sam 1625 coloring HEMANES Shale scan CORE BORING NO. calcite film 101 7 shale green Shake Chemitas 1 52017 WEATHERING <u>ک</u> 3 > 5 <u>5</u> 5 ? 3 C ,75 calcite KINEW. Pyrite Š No ર્ચ о 2 2 نځ Ş NORMORD Ş γ ž Š ş Yes THE-THESS tw +4 ż 400 M ¥ d 0 0 0 0 0 0 PROJECT NAME ASPERITY 12 5R SR 28 या 23 d Q Q DRESTATION 300 25° 300 ايزا اج. اح. إ 150 ွ် 0 5. O ° d Ō W E 2 S N  $\sigma$ ۵ つ  $\mathsf{c}$ 2 Э 2 0 W -535.3 545.54 555.7 535.3 + 545. 525.15 530.55 544.45 539.15 526.15 551.65 5.055 525.3 527-8 549.4 5.83.3 526.6 548.6 524.1 544. 551.3 551.2 547 550 A-166 Rin 6 R~4 F C 12 9 0 1 56 3 7 +

ELEV. TOP OF HOLE

PROJECT NAME

BLAV. TOP OF HOLE

CORE BORING NO. DATE:

11.ck CS-4 PAGE Stam 56 Shale REMARKS 33/ lens 26 Stale strale 4. Him shale Shake WEATHERING Ş 75 35. C 35 Z 35 Ş • calcite LENESM. Ş Š \*\* CONDICTION 20 ζ •• TIGHTHESS ¥ m  $t^{\omega}$ 0 0 d 0 0 0 0 ASPERITY ž 23 SR 52 Q Q C X DPREDATIVITION (5) 5 150 15% 150 30° 1001 , O S. 00 , Q ွိ 5 ò 1 σ J C 3 V S C d ٥ S ۵ 9 ٥ 7 ۵ 555.7 + 565.8 EE 560.85 564.05 .6-755 555.3 555.75 5.8.3 561.45 551.75 557.4 555.8 553.5 5.755 558.6 562.7 553.7 554.4 562.4 4.255 561.6 HEAD 56 A 555 527 554 A 5 17 ध ط ا <u>.</u> ع: A-167 C 3 13 14 5 = .. ŧ ó 7

ELEV. TOP OF BOLK

PROJECT NAME

CCRE BORING NO. CS - 4

المدط خ فيما له at boits -Seh HEMARKS から 26.4 Selem Shale lens shalle lens Shehe Shale Strale shade WEATHERING 55 S 22 SW S.J. 25 70 2 SN מא Un W MINEUM. ş Ş δ CONDICTION ٥ ک ર્ ر د TREATMESS ŧ I Ĭ 0 Z 0 4.6 ١, ASPERTY SP 5R 200 2 SR 28 Q Q SP 11  $\alpha$ 11 8 DPREMIMENTALINA , वन 20 ° 5 ° ° ွိ 0 E Q 2  $\boldsymbol{\mathcal{Z}}$ ۵ Q ٥ S ວ 0 2 S 7 S J 5  $\mathcal{C}$ 586 576 95 51.72 582.85 572.15 570.35 573.95 574.75 578.75 583.6 575.5 566.35 8-795 547.45 578.7 580.8 565.8 2.875 572.4 2.12 581.3 565.3 580.1 **E** 576 573 Run B Run 9 F S 이 인 A-168 8 7 ~ 3 7

PROJECT NAME

C5-4 DATE:

crystals - N - N - N Unggy Broken rick Broken tock 1cm 5 w/ gharte Iems Broken rock Scam HEMARKS Shalle Shale CCRE BORING NO. shalle Syple -m-2 WEATHERING **%** 3 C S 2 5. 20 MINERAL. ζ 915. Š ર્જ ONDATION Ş δ ર્જ TIBHTINESS TI 2 외 و Ē 0 9 ASPERITY 38 5 Sm SP SR SR V Ø DEFENTATION المًا ا °o ° <u>.</u>0 ° 'n °01 ć " 9 S) 2 C $\mathcal{C}$ 2 S 2 S S 2 2 9 S 2 S 異反片 596.3 - 606.4 596.2 TOP OF BOLE 603.55 605.5 598.65 307.30 64.15 605.3 588-75 593.85 597.6 601.2 8.409 590.3 541.8 591.3 585.4 584.4 596 HE HO 586 589 ELZV. ∞ A-169 & MO. 0 =

Crushed rock at both and 8-8-4-608.8 upon 9/akes Jam PAGE REMARKS Umggg Jalls Core breaks Ungga @ botton CORE BORING NO. deteriorated mandling Paked V~393. WEATHERING 20 لىرى S 00 S 35 5 Z \* " u 11 MINEUM. 442 Ş N2 45 80 CHOCHOK 50 ž THEATTMESS 34 3 E 0 0 7 " 0 d 0 0 PROJECT NAME Polished ASPERITY SP 성 d Sp 0 Ø B OPPEDATATION 100, 9 Ô ° õ 3 1 0 2 Q 3 ٥ a σ 0 2 9 Ŋ 0 つ V 0 9 59.719 1117 EEC 57. HI9 615.65 606.4-611.55 -24.809 612.65 6/3:25 608.05 8-609 610.T 612-35 613.8 612.15 607.3 8-8-9 611.2 609.4 606.5 +·809 8.113 1.017 1.119 HI. RN 13 S 7 MOL A 7 2 | | A-170 2 5 11 ~ 7 15 = 12  $\omega$ 9  $\omega$ 3

ELAV. TOP OF BOLE

DATE:

65-4

DATE:

Ø snake flakes C5 - 4 PAGE ود lens REMARKS CCRE BORING NO. " 'n Shake Svale shale 3-4 mm 5 m mB WEATHERING 2 55 2 S 2 " MINEW. Ŋ ٥ Ş ۸ CONDICTION Ş Ş Ş TIBHTNESS tr 立 tw PROJECT NAME ASPERITY 500 23 52 SS SR 19 N ž Q OPPENTATION 15, 12.1 203 1001 (0') ا°و) 00 150 0 ٥ 10 Ę Q.  $\mathcal{C}$ 2 ۵ σ 2 Q S 2 ۵ Ŋ 616.74 626.85 626-85-636.75 B2HQ 636.75 617.4 ELEV. TOP OF BOLE EPK 634.6 617.35 -6i4-45 624.35 622.85 620-25 621.55 6:4.2 628.3 1.229 6.779 619.7 6/6.55 614.3 HE BO 1.717 618 R.v 13 R. 4 14 NO. 23 22 3 G и и А-171

#### Appendix B Rock Test Results

Table 4.1a

Summary of Laboratory Test Results for Borehole PV at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS JULY 30, 1991

SOMIC VELOCITIES (FT/SEC)	HEASURED	WATER CALCULATED POROSITY SPEC PERM ROCK AXIAL AVERAGE DIAMETER CONTENT POROSITY		5.6 12.8 8XALE 7600 8200 8300 8200 8200	5.9 12.7 SHALE 7600 6100 8000 8200 6100 6100	6.2 13.0 6200 8300 8200 8200 8200 8200 8200	7.2 14.3 SHALE 7300 7800 7800 7800 7700 7800 7800 7800	6.6 13.3 SHALE 7400 7900 7900 7900 7900	5.7 11.9 SKALE 7600 6600 6700 6500 6500 6500	5.2 10.5 SHALE 8100 6900 9300 6900 6800
		STRAIN AT MODULUS WET	(X) (P\$1)	3.10 0.03 155.4	3.93 0.02 155.9	3.93 0.02 155.7	4.12 0.01 154.8	4.00 0.01 155.8	3.24 0.01 157.0	2.98 0.03 158.6
		I BLEV UC STRENGI	(ff) (ff) (P81)	1100	26.8- 27.1	7.0- 600	45.2- 500	5.00	500	1000
			(416)		27. 27.	254	24	35 22	79~4	£ .

\* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; BOLONITE = 2.82; RANDSTONE = 2.65.

Table 4.1b

Summary of Laboratory Test Results for Borehole PH at the UTP Portal Area

FORT KHOK, KENTUCKY - ROCK TEST RESULTS
JULY 30, 1991

						**********		JULI JU, IVI International contract con					7		37 - 31 L	111111111111111111111111111111111111111	
				٠						•		•		COLLEGE VENEZITE VII JEN VII JEN VII JEN VII VII VII VII VII VII VII VII VII VI	11164 (7	/ 3EU	:
					4102187				MEASURED	MEASURED				LATERAL	LATERAL		
SAPLE	REACH	ELEV	200	STRAIR AT	SOULUS A	LET	WATER	WATER CALCULATED	POROS ITY.	10 EC	PERM	ROCK	AY111 AVENCE	VERAGE	٥	DIAMETER	
(d.5)	(H)	(FT)	618ERG1R (PS1)	(X)	( <b>PS1</b> )	(PCF)	<b>X</b>	(X) (X)	(X)		(pg)	200		NEWALE PRESENT	1/4	1/2	3/4
PH17	17.5- 17.8		8	1.61	-	158.3	5.4	4.01	·			SHALE	8300	6300	8200 8200	0000	7900
PH26	26.7		1100	1.70	0.07	158.0	6.4	10.6	ž.			SKALE	860	999	8300 8900	800 800 800 800 800 800 800 800 800 800	8200 8800
PIG2	32.3 32.5		1100	1.33	0.0	159.8	4.9	9.6				SHALE	98	999	8500 8600	8700 8800	8200 8800
P#44	## **		1200	1.43	0.09	150.7	6.4	10.2				SHALE	<b>6500</b>	8700	8500 9000	850 800 800	<b>92</b> 00 <b>8</b> 000
PH66	33 4		1200	1.20	0.10	158.8	4.5	9.6				SHALE	9	8900	8900 8900	8900 8500	88
PH69	89.2 89.5		000	1.45	9.0	158.4	5.1	10.5				SHALE	8	8700	8200 8600	8100 9000	<b>6</b> 300 <b>9</b> 500
PH101	101.9-	•	1000	1.55	<b>90</b> °0	159.5	4.5	4.6				SHALE	0006 -	0006	8500 9500	8200 8200	<b>9</b> 500
PK121	121.7-		909	2.62	90.0	159.0	5.1	10.2				SHALE	8700	900	8200 9200	8700 9300	8700 9200
PH145	146.2		1000	0.60	0.14	161.5	4.3	1.0				SHALE	828	9200	9700 9400	9200 9600	009 <b>6</b>
P#160	160.0- 160.3		000	1.36	0.0	159.6	4.5	9.X				SHALE	9800	9700	9300	0056	10000 9700

**B-4** 

- ASSANCE VALUES OF SPECIFIC GRAVITY WERE: SHALE - 2.70 (2.60 FOR NEW ALBANY); LIMESTONE - 2.71; DOLONITE - 2.62; SANDSTONE - 2.65.

Table 4.2a

POAT ENEW, KENTUCKY - ROCK 1887 RESULTS NAY 6, 1991

					-								_	SONIC VELOCITIES (FT/SEC)	CITIES (	7/860)	
				MIV	*******				•	PEASURED		;		<b>E</b> S	LATERAL	_	
	140	2	STRENGTH	SAINE AT	200 ×	PENSITY	CONTENT	CALCULATED POROE ITT®	2	22	e i	ğ E	AXIAL	AVERAGE	91ME	PIMETER 12	3/4
(1-65)	1	€	Ê		ŝ	I	8	8	3								
-	ĒĒ	5.05	<b>8</b>	E.	0.33	139.3	4.0	2				BUALE	10900	11800	25 25 25 25	88 55 55	22
=									6.7	2.78							
2 5			•							1.7							
~	Ė		8	1.67	0.63	160.4	3.6	3				EINTE	10600	180	25 25 25	800 ===	1200
8									10.1	2.77							
			•						4.2	2.7							
	2		4500	<b>E</b>	6.23	1.031	4.0	5:				STALE	<b>9089</b> .	<del>2</del> 8	2 <u>2</u>	## 88	88 22 88
8									9:0	2.78			٠				
: 4									••	2.73							
ł .	İ		799	2.	0.30	163.0	3.5	53				ORAŻE	1050	11900	1300	25 88 88	22 28 88
•									:	£.							
2 1										2.7						•	
8	Ki		2800	3.	9.14	161.0	•	8.2				STALE	1000	11800	15.00 1300 1300	202 202 203 203 203 203 203 203 203 203	88 ===================================
1									9.0	2.7				•			
2	į								6.3	2.76							
•	EE		<b>35</b>	2.10	0.13	161.0	4.0	<b>9.</b> 5					\$	1300	<u> </u>	25 25 25	25 28 28
=	3.5								53	2.7							
ğ	2.5								 	2.2			•	3	. \$	-5	2
-			4100	1.74	6.5	4.1.6	7.	2					395	3	<u>\$</u>	12100	12000
5	20.00								:	2.7						-	
3						•			<b>7.</b>	2.78	•			,			
<u>.</u>	116.1		4100	2.	2.31	161.0	W.9	:				FALE	10300	8 <del>-</del>	88 	000 25 25	200
5	310.9				1			-	5.5	2.68	1 9.82 E	CAMPATONS - 2.45	2.65.				

Table 4.2b (page 1 of 2)

PORT ISHOW, ICENTUCKY - BOCK TEST RESULTS HAY 6, 1991

													ľ	Carrie in the same of the same	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1496	
														MONTH AREA		(11/166)	
									<b>.</b>	KASURED	•		•		LATERAL		
•		3	Ē	_ t	YOUNG'S		WIE	CALCULATED	POROSITY 6	2	3	NO.		,		DIMETER	
	<b>5</b> 5			NUMB Second	× E	(PC)		CONTENT POROSITY* (X) (X)	æ	A A	ā	341	AKIM	AVERAGE	٤	2	ž
:	7 77.	l		1					0.4	2.80							
: 2	325.0	¥ .							:	2.78			i				
l <sub>.</sub> -		Ë	<b>9</b> 4.	£.	6.2	160.6	<b>3.</b>	5.3				SHALE	<b>%</b>	1200	### ### ###	<u>88</u>	<u> </u>
:									1.1	2.74							
; ;		K. 2.							<b>8.9</b>	2.7							
		33	<b>6057</b>	2.2	6.1	161.5	<b>9</b> .	4.7				BRALE	10200	2100	22 20 20 20 20 20 20 20 20 20 20 20 20 2	527 527	\$22 882
5	155.0	154.3	•						•:	2.61					•		
: 4	7	¥3.			•				7.4	2.73					•		
	33	2.5	260	8.3	6.1	161.6	4.3	:				BILALE	<b>13</b> 8	220	<u> </u>	<u>27</u> 88	<u> </u>
	r.	ă				•			10.1	2.81							
: 2	¥.	124.7					٠		:	<b>2.</b> 3						:	,
-	7.55		4300	÷.	0.21	161.7	¥.9	7.7				SKALE	0 0 0	12800	125 277 200	125 25 25	
3	ž	319.2							7.5	2.77							
3	7.4	314.9							7.0	Z. 73							
3	46.1	308.2	٠						.:	Z.7				•			
3	1.691	304.2							:	2.77		!	i		1	1	1
•	4.69.3 4.09.1	25	90	<b>6.</b>	<b></b>	161.8	ů.	7.						B/21	200	22	200
z	415.1	2. X							6.5	1.1	•						
2	1.72	2.88.2							7.2	2.74						•	
8	12.6	7.02							7.	7.7							
•	7.87	200.5	4			160.8	•	=				SHALE			•	•	
3	1.43	273.2							9.6	2.73							
3	435.8	Ë							7.5	2.7							
<b>3</b>	442.8	244.5	,							<b>7.</b>							

Table 4.2b (page 2 of 2)

PORT ENCH, EDITUCKY - ROCK TEST RESULTS
(LONT [TANA)
(cont. [nad])

SONIC VILOCITIES (77/WG) LATERAL	DIMETER 1/4 1/2 3/4		00/21 00/21 00/21			00071 000K1 001K1			•	1700	1200
ONIC VIE	AVERAGE	į	12/80			8					:
	AXIAL		<b>8</b> 4	·	;	<b>8</b>				40.50	}
	ăĒ.		SINTE			CARBON				-	
	M (P										
HEAGURED	SPEC BEAV	2.10		2.2	2.63		2.43	2.57	2.2		
Ä	POROBITY SPEC PERM (EA/)										
	WATER CALCULATED CONTENT POLOSITY* (X) (X)		18.4			15.4				i	¥:2
	WATER CONTENT P	ŀ	1.2			1.7					
	PER (SC)		139.2			143.1					147.3
	MANAGE CHARACTER COLUMN		<b>1.</b>			9:0					3
	STEAIN AT FALURE (X)	1	1.69			8.9					97 -
	STEER CO.		13900			676					944
	2 6	263.0	259.1	77	245.2	29:2	1	274		2.2	
		3	450.2	1.887	=	e e	, K			3	
	SAPLE SUBSE	8	~	2	: <b>c</b>	•	4	<b>.</b>	3	2	,

+ SPECINEN WAS TOO DECKEN TO TEST. • ASSUMED VALUES OF EFFICE GRAVITY MEDE: GUALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLONITE = 2.82; SANDSTONE = 2.45.

Table 4.2c (page 1 of 2)

PORT EDICK, KEDITUCKY - ROCK TEST RESULTS NAT 6, 1991

														BONIC VELOCITIES (FT/REC)	SCITIES	(FT/BEC)	
				77.77					NEASURED	MEASURED				LATERAL	LATERAL	3	
SAW!	DEPTH	CT2	UC	UC STRAIN AT			WIER	WIER CALCULATED	POROSITY	22.2		X S	TATAL			DIAKTER	
9.0	3	3	î.	8		1	8	8	(X)		ĵ				٤	2	ş
-	33		25	2.8	3.	161.1	5.5	:				BINTE	824	11600	25 88 88	22	22
=	366.3	344.4							:	2.77			į				
<b>a</b>	373.4	105.3	٠						7.	2.79							
~	EE.	327.9	2809	3.	0.13	161.7	7	9.0				SKALE	8	11800	== 58	== 88	25 200 200 200 200 200 200 200 200 200 2
*	7.7	324.3							7.0	<b>2.</b>							
	38.3	314.4	•						;	2.7							
~	. 7. 7. 69 69.7.	306.1	1400	9.31	0.40	139.4	7.	17.0				BHALE	1460	14400	22 88	25 25 88	500 SE SE
2	1.901	39.3							1.	Z. 3					•		
3	416.3	7. ¥2.							4.7	2.74							
- <b>~</b>	£2.7 £4.1	 333	1800	1.49	9.23	162.0	;	4.5				BIALE	8	13000	<u>ră</u>	22 80 80 80	25 25 26 28
2	136.2	24.5							9.6	2.76							
3	134.2	274.5								2.17							
•	33	33	15300	2.50	r.	137.3	7	1.4				CARBON	9600	13000	500 80 80 80 80 80 80	20 22 22	27.7. 20.7.7. 20.00
2	1.7	24.0								2.2				•			
š	456.8	23.4							•	5.49							
=	67.0	23.7								2.39							
•	33	246.5	200	=	0.57	163.3	•	13.3				SINTE	20	16200	9065	<u> </u>	15908 15908
22	476.7	234.0								2.45							
-	. S. S. S. S. S. S. S. S. S. S. S. S. S.	27.22	10800	7.	2.8	151.2	?	:				CARBON	1100	14400	<u>33</u>	22 88 88	<u> </u>
2	0.784	7.22								2.38							
148	1.94.	213.9								2.74							
•	58.4 54.4	206.8	99	1.2	7	154.7	1.7	<b>6.3</b>				SKALE	10900	15200	22 22	25 80 80 80 80 80 80 80 80 80 80 80 80 80	88 22 22
138	\$07.2	203.5								2.50							
					-												

Table 4.2c (page 2 of 2)

PORT ENCH, EENTUCKY - ROCK TEST RESULTS
ANY 6, 1991
(confinmed)

*******	************				Person species	***************************************					ĺ			SOURCE VELOCITIES (FT/SEC)	CITIES	(34/14)	
									3						I ATTRACT	=	
								,	Camberal				•				•
EVICE		ELT.	3	-		5	MTER			Žį		ğ	AYTAI	AVERAGE		STANTES	
20	Ê	E	E CEST	38	<b>3</b> 2		<b>E</b> E	(X) (X)	æ		Û				ž	5	ž
	1	1 1 1							22	2.6	0:02						
3	•										0.0		;				
•		10.4	5500	8.6	2.01	163.9	2.2	•				1971	15800	1620	500 600 600 600 600 600 600 600 600 600	35 38 38	23 33
Ē	22.72	18.5							<b>8.</b>	2.01	•••						
3	538.6	12.1							5.0	2.84	22						
2	25.5	. 991	2700,	<b>3.</b>	3	130.0	2.	1.1					1730	16708	1538 14400	23 88	35 35
2	E	<u> </u>							17.8	2.87	87.68				٠.		
208		¥.							12.8	2.87	7. 2.2.						
=		145.9	12,600	2.	8.8	<b>6.8</b> .	3.6	3.2				<b>1907</b>	1700	1788	55 88 88	27. 88.	<u> </u>
218	25.53								:	28:	33.			٠			
												-	;				

\* ASSENDO VALUES OF EPECIFIC GRAVITY MERE: SMALE = 2.79 (2.40 FOR HEW ALEANY)) LIMESTONE = 2.71) DOLOKITE = 2.62; GANDETONE = 2.45. \*\* HORIZONTAL (CLOSS-AXIS) VALUES FIRST VALUES I FIRST VALUE IN THE FIRST.

Table 4.2d (page 1 of 3)

FORT IDIOX, KIDITUCKY - NOCK TEST REBULTS NAY 7, 1991

***************************************													ľ	SOUIC VELOCITIES (FT/FEC)	11100	1/880)	
									9	MEASURED FO				LATERAL	LATERAL	_	:
		i		AKIAL				CAL CIR ATED	FOROS	2	DEED No.	¥00		DIANETER		DIAMETER	
		<u> </u>	STATE (187)	358	M C	ES	100 100 100 100 100 100 100 100 100 100	CX) (X)	8	CECAV	ĝ	E.	AXIAL	AVERAR	3	2	\$
=	54.2	ž.							<b>9</b> :0	2.74							
-	407.5	313.5	9062	7.7	<b>X</b> :0	4.14	;	7.9				SIMIE	8	12700	272 88 88	227 288 888	27 28 28 28
=	414.7	206.3	٠		•				4.7	2.7							
2	2.8	23.5							7.3	2.74							
~	427.5	222.5	1700	÷.	<b>7.</b> 0	170.3	7.7	3.4				SIMIL	<b>2</b>	<u>2</u>	8 <u>8</u>	2 <u>2</u>	######################################
. *	. 7	244.1	•						0.	2.73							
<b>5</b> ;										2. 2.					•		
3 ,-	3	27.1	10700		1.1	134.5	7.7	15.4				CARBON	84	13300	22 88		25 28 28
:		7.575								2.31				,			
<b>4</b>		28.0								2.4							
	3	22	7800	<b>a</b> .	2.	149.6	:	?				CALLOR	8	14000	27 28	27 22 88	23 28
. \$	474.9	244.5								2.4							
,	33	ត់ត	10200		1.55	131.6	2.0	:				SINTE	2040	14000	55 55 56	<u> </u>	23 23
3	3	2.2								<b>3.</b> 44				•			
=	436.4	24.4								<b>5.</b> 2							
×	905.9	215.1								2.30					3		
•	505.4	2,4.5	8	6.9	1.47	149.9	7.	:					9090	8	<u> </u>	<u> </u>	3
4	514.6	7.70								2.45						•	
3	523.0	198.0							6.0	2.7	72.0						
-	927.6		13100	1.57	1.7	1.731	3.6	22				젍	16100	16500	23 88	33 88	<u>33</u>
2	2 22								9.2	2.01	0.0 0.07						
E	¥	176.4			-				17.6	2.84	2005						

Table 4.2d (page 2 of 3)

FORT IDICK, KENTUCKY - ROCK TEST REBULTS WAY 7, 1991 (continued)

LATRAL	E E		88 500 800 800 800			88 <u>111</u> 800 800			88 110 110 110 110			20400 14308 20400 19400			15500 14508 15800 14808			88 88 88 88 88 88		
3	DIMETER	٤	240 17800			500			<u>***</u>							-		2 2 3 3 3 3 3		
LATERAL		₹	13500			== 88		•	2.5 2.5 2.5 2.5 3.5			24 24 26 26 26 26 26			55 88			<u> </u>		
		AWEXAR	1700			16500			16700			<b>679</b>	•		1570			17600		
		KIK	15700	į		18600			9046	•		1770			15500			17400		
	BOCK	Ĕ	ğ			. 절			ጀ			절			STALE			<b>185</b>		
	L	ĵ.		5.73 5.89	12.51		22.22	28			23			E3		22	25. 50. 0		 	9
•	٠			2.8	2.63		¥.	2.63		7. 2.	2.2		7.	7.		2.3	2.8		2.8	ĭ
2	POROSITY SPEC	£		4.0	11.1		e. R	5.3		;	••		3.2	•		9.0	1.1		<b>5.</b>	•
,	EALGRATED .	CONTENT PORCELITY (X) (X)	16.7			7			*		•	11.1			:			7.7		
	24778	(X)	27			•			:		÷	9.0			2			2.7		
			153.4			17.3			170.0			162.4			170.7			107.7		
	TOURS'S	2 2 2 3	5.			4.			<b>F.</b>			2.5			£.			z.		
	אוא	38	6.30			9.42			4.47			12.0			•.41			9.3¢		
	•	STRENGTH PAIN	% % %	•		1870	•		13200			<b>1800</b>			649			12300		
				163.4	154.5	. 22.5	149.4	136.9	E.	12.6	19.1	113.9	10.5	ž	X.	87.5	7.27	×:	67.2	
			١.		54.5	5.7.7	7. F.		.1.785	24.5 22.4	. 8	. 507.5	607.V	1.13	3.5	8	£.3		53.0	
				3	=	•	\$	2	2	ই	2	=	<b>₹</b>	=	=	ž	ž	2	¥	

Table 4.2d (page 5 of 3)

FORT DIOK, KENTUCKY - ROCK TEST RESULTS
(MAY 7, 1991
(continued)

ĒĒ	ě E	UC STRENGTH (PSI)	AKIAL STRAIN AF PAIUMS (X)	TOLORO'S HODULUS K EDA (PSI)	MET DEBISTY (PCF)	MIER CX)	WATER CALCULATED CONTENT PODGITY (X)	POROBIT (X)	MEABURED T BPEC GRAV		ME TE	ARIA	EXIL AVELANT 1/4 1/2 3/4		ILIES (17/24C) LATERAL    1/4 1/2 3/4	\$ S
35			6.38	. 27.5	ī.	2	• •	3	2.5		<b>5</b>	9024	16300	<u>77</u> 88	2 <u>2</u>	77 20 20 20 20 20 20 20 20 20 20 20 20 20
• •		818	3.	1.8	167.2	:	 •	}		6.51	절	1440	97	22 20 20 20 20 20 20 20 20 20 20 20 20 2	**************************************	1500 1500 1500 1500 1500 1500 1500 1500
1 T		•							2.8 6.9	22						

Table 4.2e (page 1 of 3)

PORT ICHOR, KENTUCKY - DCCK TEST REBULTS HAY 7, 1991

		is				22 88 88			13200 13200			25 25 26				88 55 55 55	;					500 502 502 500 500 500 500 500 500 500	
/ <b>XE</b> C)		PLANETER 1/2				22 88 25			23 23 25 25			33 88 52				33 33		<u> </u>		_		902	
	STEER A	P1.4 1/4 1/2				22 22 23 25 25 25			22 88 28 22	.•		25 25 25 25				22 88 22		28 28 28 28 28 28 28		•	•	861	
111001	3	-																					
SOUIC VELOCITIES (FT/BEC)	LATERAL	AVERABE				12400			13900			13906				7		906				1600	
		XIX		į		28			10900			90 .				900		<b>2</b>				178	
		ME TO	FRALE	SIMIE		CARDON			ENTE			CALE				CARBON				LHEST		ಕ್ಷ	
	;	. G	•						-			-						_	88	_	132.00 205.00	_	2.57 -
	8				r		2.26	*		7.2	2.45		2.42	2.38	2.51		2.32		2.74		2.81 Elv		2.01
	MARKED	T SPEC	-		Z. 3		~	2.2		~i	zi		'n	~	ä		~i		~i		~		~i
	•	POROSITY SPEC (X)			4.														.:		5.7		2.9
		CONTENT CALCALATED CONTENT (X)	7.	•		15.9			7.6			10.4				•		0.5			•	17.0	
		35		_					_												•	·_	
		NEW X	3.6	4.3		1.3			7.			2.0				2.2		6.3		1.5		5.1	
		PERSONAL PROPERTY COSTS	163.5	160.0		130.3			153.2			7.8.4				152.7		16.3		17.9		153.6	
		MCDULUS X EOG (PSI)	0.27	0.1 <b>a</b>		8. 8.			7.3			1.37				3.5		8.8		2.50		3.07	
			1	ė		ö			÷			÷				÷		si.		N		m	
		STATE AT AT AT AT AT AT AT AT AT AT AT AT AT	ē.	1.2		r.			5.0			5.		•		<b>6.7</b>		0.42		3.		8.	
		emerical (PSI)	80%	92.		12100		•	878			90100				8		4200		804		9007	
		3 6	1.		272.0		722.4	3.5	5.53	6'372	23.1	. 5.2% 2.4%	243.1	23.6	23.3		214.1		4.162	9.90	<b>1 2</b>		181.8
		# (F)										٠						521.0 521.5	521.7	<u> </u>	332.0	6.6	¥ 5.3
		EVANT RUBER (CB-6)	"	~	=	n	8	1 #		5	: =		4		: 3	•		-	\$	ĸ	=	-	2

Table 4.2e (page 2 of 3)
roat mox, kentucy - hox rest assuts
kentlesed

			×			17500			17400		17100				17400 18200			٠	80165		
(11/EC)		PLANETER	۲			\$8 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2 \$2			88		88				258 200 200			•	25 25 25 25 25 25 25 25 25 25 25 25 25 2		
T168 CF	LATERAL	•	ž			887		•	505 505 505 505 505 505 505 505 505 505		25. 20. 20. 20. 20. 20. 20. 20. 20. 20. 20				952T				9044		
SCHIC VELOCITIES			AVEZA			17200			18600		90191	•		•	17800				19800		
•			MIM	1		1700			19300		17200				16900				20100		
_		BOCK	Ē	À		<u> </u>		•	절	•	쥝	•	ğ	·	ğ	•		•	ğ	ğ	
		, Kar	ŝ	zz.	28		<b>5.</b> 6	*-	-	-8 -8		1515.88 622.88		0.15 5.15		12.27					
	MEASURED	Ĕ	à l	2.84	2.	_	7.8	ž.		2.83		2.8		2.8		2.8	2.7	2.8			
	3	PORCELTY SPEC	8	9.4	:		7.	1.4		3.2		4.0		;		-	2.7	4.4	-	•	
		CALCULATED	CONTENT POROBITY (X)			:			5.7		10.5		*		<b>6.3</b>			٠.	.; •	5.	
		WITE	CX)			3.5			<b>2.</b>		4.0		2.0		2.				ı.	=	
			CPCF)			165.6			18.4		163.0		162.7		168.7			-	171.4	16.	
		YOUNG'S	X 104 (71)			2.59			19.9		74.0		2.		6.9				4.7.	7. 2.	
		AXIA.	A STURE			9.4			6.3		£.		8		9.39				*	0.67	
		2	CPSI)			1020		•	13100		<b>8</b>		8		8				18900	200	
		. 2	E	1.61.4	12.3	2.131.0	152.4	1.23.1	142.9	¥ ¥	2.5	111.7		114.5	4.5	. 8 		8	5.	3 2	7.1
			E	533.7	<b>3.</b>	33	Ë	560.0	83		9.		â	; ;	5	£ 2.5		7.63	. 9.63	3	5,177
			2 2 2 3 3 3 3 3	5	\$	•	55	3	2	Ē	=	Ē	#	<u>\$</u>	2	2	;	8	2	ž,	!

Table 4.2e (page 3 of 3)

ton now, kinnexy. nox rest neuts

NN 7, 1991
(continued)

													-	CONIC VELOCITIES (FT/FEC)	17100	FT/NEC)	
									₹	PEABURED			•	LATERAL	LATERA	-	
	102	2	9	_	TOURS'S	Ì	WIER	CALCULATED	POBOBITY	2	PERM	X		*******		OLVETER	
		į §	(PSI)	NE SEE	Z.			PORCE IT	8		Ē		I		٤	5	ž
=	439.9			x:	4.17	19.2	3	5.3				젍	19500	18600	\$ 5 8 5 8 5 8 6 8 7 8 8	<u>ř</u> ř 88	2005 2005 2005 2005 2005 2005 2005 2005
972	£ 6.5								5.5	2.8	33		ŀ				
ន	6.E								S.0	7.	88	,					
*	679.0		926	.6.	2.05	163.5	ä.	2				BEALET	14500	14.100	₹₽ 28	35 88 88	2300 4400
3									*	2.8	= 8 = 8						
Ë	19.3								;	E.3	2.0 2.0				•		
후			12200	6.41	3.10	160.0	0.3	6.2				<b>E</b>					
2			8	2.	1.6	163.4	6.3	2.5				5	1870 00	18200	32 88	22 22	<u> </u>
2	E								•	2.7	28						
11			11200	<del>2</del> .	7.	18.2	2	1.1				<b>5</b>	16700	<b>2</b> 8	<u>55</u>	23 88	97 <u>7</u>
<b>=</b>		. 4.9 . 7.9		\$	<b>25.</b>	<b>16.9</b>	2	<b>6</b> ;					15 84	9021	<u>7</u> <u>7</u> 88	25 88	<u>53</u>
									1		-		*				

\* ASSUMED VALUES OF SPECIFIC GRAVITY MENE: SHALE \* 2.70 (2.40 FOR HEW ALEMAY)) LIMESTONE \* 2.719 DOLOHITE \* 2.42; SANDSTONE \* 2.65. \*\* HORIZONTAL (CHOSS-AXIS) VALUES FIRST VALUE IS THE PARIMAN FOR THE PLUG; SECOND VALUE ONTAINED PERFERDICALAR TO THE FIRST.

Table 4.2f (page 1 of 6)

PORT ISHOW, IGHTUCKY - ROCK TEST REBULTS MAY 7, 1991

													-										
			\$	22	\$ \$ \$ \$	<u> </u>	<u>1090</u>	25 26 26 26	25 26 26 26 26	## 88	90821	22 22 23 23 20 23 20 20 20 20 20 20 20 20 20 20 20 20 20	12400			## 89 89 89	1100 1000 1000		25 85 86				
1/460		DIAMETER	2	25 88	\$\$ \$\$	88 88	\$ 5 5 5 5 6 6	88 88	250 200 200 200 200 200	<u>\$</u>	<u>23</u>	12308 8023	<u> </u>			3 <u>8</u>	1390 1390		<u>88</u>				
SOMIC VELOCITIES (FT/SEC)	LATERAL		š		88 <del>4</del>	128 288	979 970	11000	1060	<b>S</b>	22 22		13200 12400			255 256 266 266 266 266 266 266 266 266	17.00 17.00 10.00		22 28 28 28				
ONIC VELO		AVERAGE		\$	\$	10000	10600	1200	10900	218	12000	12300	1270	•		13100	13900		12100				
•	•	ACIAL		870	9004 :	8	9	9023	80	Ē	8	904	10200			11200	9053		16300		•		
		100 100 100 100 100 100 100 100 100 100		STALE	BINIE	STALE	BINTE	STALE	BLALE	BIALE	STALE	SHALE	SHALE		STALE	SKALE	BHALE		ಕ್ಷ				
		2	3															× 9.01		× 0.01	<b>♦ 0.01</b>	₹ 0.01	<b>4 0.01</b>
	HEASURED	23																2.2		2.82	2.7	2.62	2.8
	MEA	POROSITY	8															2.7		<u>.</u>	9.0	•	;
		WATER CALCULATED	8	10.4	7	:	7.8	:	=		18.5	13.3	1.1	5.6	3	2.0	1.5		9.¥	•			
		CONTENT	8	•	<b>3</b> ·	<b>*</b> ;	9.°	4.2	7:	4:4	<b>8.0</b>	1.3	•:	3.0	2.3	2.0	:		2.7				
				157.5	139.0	160.0	161.5	161.4	161.7	161.0	1%.	142.5	147.0	162.7	155.6	163.6	143.9		. E.				
		annou x	ŝ	į	:	:	į	i	:	9.18	1.1	<b>3.</b>	÷.	11.86	10.32 22.02	0.72 17.00			3.				
	;	STRAIN AT	8	2.8	3.	3.	 8.	1.06	1.27	÷.	<b>3</b>	1.27	6.53	6.13	9.30	9.76	9.44		2.0				
		200		1000	220	200	270	2000	8002	1600	7300	11500	85	. 3300	3000	920	7,00		12000				
		ELEV	£	416.2 415.8 ·	33.5	13.5	35.4		315.6	EE.	 	26.5		215.9	215.0	215.3	** •	1.54	122.7	189.9	189.2	- IR.4	12.2
		EFTE	£	7.55	25		. 7.101	121.4	141.3	12.4	185.2		is is	240.6	22.2	241.6 242.6	25.32 25.7.32	2.03	25.2 25.2 25.4	247.0	7.872	m.s	274.7

Table 4.2f (page 2 of 6)

PORT DICK, ICHTUCKY - ROCK TEST REBATS
MAY 7 1991
(continued)

														SONIC VELOCITIES (FT/SEC)	C171E8	(236/14)	
									HEASURED	HEASURED				LATERAL	LATERAL	=	
EMBLE	III da	E C	3	OTENIK AT	MODIFIES A	5	M TER	CALCULATED	POB08177	Ë	Ē	ğ	AXTAI	702-100		DIAMETER	_
(FK-1)	£	£		MIUME	ž:	(100)	(X)	3	8		Ē				٤	1/4 1/2 3/4	ž
=	15	17.5							3	2.7	4 6.01						
<b>\$</b>		7.0	14600	9.4	3.6	168.0	2.7	7.				ğ	16300	1630	25 25 26 26 26 26 26 26 26 26 26 26 26 26 26	<u> </u>	<u>F</u> E 88
5		17.9	•					•	3.4	2.01	<b>6.01</b>						
3	22.5	174.4							5.3	8.8	₹ 0.01						
	24.8	1.2								2.2	<b>. 0.01</b>						
	27.7	16.6	•						;	2.5	÷ • • •						
	• 84	6.07							•	<b>2.</b>	0.27						
	2	7.7		•					7.2	2.63	. 0.01						
<b>=</b>		7.2	7600	77.	4.07	13.0	<b>.</b> .	1.7		٠		젍	19500	14500	910	\$5 80 80 80 80	22 22 22
<b>1</b>			3900	9.74	3.	145.3	7.7	9.0				ಕ್ಷ	2808	13600	17300	<u>===</u>	500
;		4.21							7.5	2.6	3.8						
<b>:</b>									6.0	2.2	7.2						
2 2			3	2.0	4.33	163.8	3.7	10.2				절	19000	<b>S</b>		<u>25</u>	
\$		150.7	٠						9.	2.8	2.3			•			
			\$	6.15	to.09	142.8	7.7	10.4				<b>ğ</b>		,			
*			92.		57.5	163.6	3.5	1.01				- <u>z</u>					
22	20.2	138.7							12.3	2.2	322.00				•		
2	X00.0	156.9							14.2	2.8	126.00					-	
2	302.0	₹.÷							7.5	2.8	3.						•
\$	265.0	151.9							4.7	<b>3.</b>	9.0						
3	26.5	150.4							;	7.8	6.7					•	
Ē	310.0	146.9							9.2	7. 7.	8.						
3	311.7	145.2							2	2. 2.	<b>S</b>				•		
Ē	313.7	163.2							16.2	2	37.6						

Table 4.2f (page 3 of 6)

PORT ICHOM, KENTUCKY - BOCK TEST REBULTS
(MAY 7, 1991
(continued)

														BORIC VELOCITIES (FT/FEC)	CITIES	FT/FEC)	
									¥	MEASURED				LATEAL	LATERAL	=	
. I I I I I	11414			AXIAL STRAIN AT	YOUNG'S	ž	WATER		POROSITY SPEC PERM	2	Ę	XOCK		• I METER		e i Aveter	
2. X-3.	E	£	CPSI)	FAILURE	X	PERSIT (PCF)	CX)	CONTENT POROSITYON (X) (X)	8	AZA BEA	ĵ	¥.	AXIAL	AWELVOE	ž	5	ž
2	¥.5	160.4			·				16.0	2.77	152.00	-					
218	310.7	130.2							7.5	2.64	9. 6		:				
<b>=</b>	321.4	133.5	•						10.3	2.2	0.62						
1	XX XX 3.53	133.4	8064	0.32	8.8	163.3	7.7	10.0			•	g	1230	12800		13000	1770 1770 1770 1770
2	322.0	134.9							10.0	2.63							
ŭ	24.4	12.3	•						7.7	7.5	6.11						
572	326.0	130.9								7.2	c.2				•	•	
ឆ	329.6	127.3							3.7	<b>%</b>	e.02						
92	2715	12.7							5.9	7. 7	A 0.01				•		
Ë	33.6	123.3							3.7	2.6	A 4.9						
3	226.6	120.3					•		<b>8.0</b>	2.8	2						
<u> </u>	340.6	116.3							2.2	2.2	<b>* 0.9</b>				•		
=	340.7	116.2							2.5	<b>3.</b>	6.6		-				,
=	¥41.7 ·	115.2	20700	8.0 22	. x	12.3	•:	<b>5.</b>				) 2 2 3	2000	op.		17100	<u>55</u>
34	¥2.2 ¥2.5	- 11:7	8	41.0	10.44	173.2	•	2.2				<u> </u>		•			
2	¥2.5	11.1	13600	<b>3</b> .	<b>6.</b> 2	17.5	9.0	<b>9</b> .2				<b>18</b>					
£	343.3	113.6							7.6	2.12	<b>.</b>						
Š	¥.7	112.2							2.0	2. E	¥ 9.9						
318	347.2	109.7							;	2.	<b>8</b> .5					-	
=	351.6	105.3							7.7	2.63	1.47						•
ñ	351.0	15.1	<b>670</b>	0. 2	3.6	5.	3.7	:				ğ	155 8	13600 00	27. 26. 26. 26. 26. 26. 26. 26. 26. 26. 26	\$2 86 86	<del>2</del> 28
2	352.3	44 44 -	2200	0.17	<b>4.5</b>	139.7	4.	13.3		1		<b>호</b>					
328	352.9	18.0							12.9	7.6	167.00						

Table 4.2f (page 4 of 6)

FORT DICK, ERFLUCY - ROCK TEST RESALTS
MAY 7, 1991
(continued)

-														SORIC VELOCITIES (FT/SEC)	XITIES	(FT/8EC)	
									¥	HEABURED				LATEM	LATEDAL	<b>W</b>	
		2	£	AXIAL ETEXTE AT		5	ATTA		PORCE ITY SPEC		5	<b>EOCK</b>				DIAMETER.	-
SECTION OF THE PERSON OF THE P	<b>E E</b>	3-8		STREMETH FAILURE (PSI)	Z (E			CONTENT POROSITY** (X) (X)	8	š	ŝ	E.	W.W	AVERAGE	٤	1/4 1/2	۶
,	i i	18.8 6.8	620	87.0	3.7	163.5	3.6	10.3				절					
2	187.7	~							5.5	2.8	9.05						
=	32	9.4							7.7	<b>2</b> .	<b>* 0.01</b>						
· •	333	**	11000	77.0	5.37	171.5	5.5	3.				<u>z</u>	906	1470	5020 0200	<b>8</b> 8	<u> </u>
×	X2.6								5.6	2.63	<b>6.01</b>						
25	74.7	72.2	•						3.0	2.8	<b>6.0</b>						
3	364.6								17.0	<b>2</b> ;	4.2						
2	33.2		<b>8</b>	\$	<b>3.</b>	16.8	2.0	3.6				SHALE	10900	13400	1630	25 25 25	23 88
3	302.0								3.3	2.E	<b>. 0.9</b>						
	¥.0			•					7.7	7. 7.	6.2						
5	266.0								<b>6</b> :0	2.	· 0.01						
=	X								;	2.6	a.						
5	35.0			•					7.3	2.6	8						
<b>.</b>	N.Y.								:	2.63	8.			•			
z	33.0		15000	0.32	6.43	16.0	52	•:•				<b>g</b>	<del>2</del> 200	<u>8</u>	500 000 000	14100	280 200 200
5	335.5								2	2.E	9.0 20						
=	376.2								:	2.0	9.8						
157	1.007								7.7	2.8	8.						
÷	£ 5 5 7	92.4 52.2	10800	9.3	3	168.5	<b>5.</b>	<b>6.7</b>				ಕ್ಷ	25	24	16590	2.5 2.5 2.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3	<u> </u>
. 25	1.404								11.3	٠. ع	<b>6.3</b>						
3	4.504								7.	<b>3.</b>	•.0 •					•	
Ę	7.607								6.0	7. 2.	0.33						
a	410.4								;	2.0	9.E				į		
a	410.9	33	13100	0.21	7.55	167.6	<b>%</b>	7.2				ಕ	<u>F</u>	<u>8</u>	885 285 285 285 285 285 285 285 285 285	25 25 25 25 25 25 25 25 25 25 25 25 25 2	

Table 4.2f (page 5 of 6)

													_	SOULC VELOCITIES (FT/NEC)	CITIES	(11/860)	
									¥	HEASURED					LATERAL	Į.	
באפונ	MT-230	25	3	STEALS AT	MODULUS	7	WATER		POROSITY SPEC	ž		200				DIANTER	
(1K-1)	CLLO	(m)	(184)	(X)		(PCF)	(X)	(X) (X)	(X)		3	1	AXIAL	AVERAGE	<b>×</b>	7,	×
3	412.6	4.3							=	3.	1.7						
<b>8</b>	417.7	39.2							7.3	2.83	. 0.01		•				
8	419.9	37.0	•							2.8	0.0						
35	422.0	X.•							5.1	2.64	20.0						
n	1.83	31.2		-					7.4	2.2	<b>•</b> .01						
ສ	42.8.4 426.2	50.7	800	9.36	3.12	167.9	\$: *	7.2				STALET POL	15200	13000	1090	25 25 28	15000
238	1.77	30.5							7.7	2.63	0.02						
z	430.9 -	22 25 25	8	6.33	<u>x</u> .	7.331	3.0	9.0				절	14300	15400	•	15300 15400	
×	431.5	7.82							1.1	2.2	<b>₹ 0.01</b>			•			
22	431.8	<b>8</b> .1							7.7	2.7	0.10						
348	134.2	27.7							•.	2.2	× 0.01		•				
35	440.5	17.7							7.3	2.0	<b>.0.0</b>	•					
3	443.0	13.4							1.7	2.2	9.0						
5	446.7	10.2							3.6	<b>2.3</b>	<b>9.</b>						
8	4.7.0	:							1.9	2.7	9.9			•			
ຸສ	****	7.7	10000	o. 2	<b>6.</b> 3	167.2	0.3	<b>Y</b> .				BIMLEY	19600	13800	<u>70</u> 20 80 80	\$25 80 80 80 80 80 80 80 80 80 80 80 80 80	2500 2000 2000
n	448.8	:							•:	2.7	<b>← 0.01</b>						
4	452.2	4.7							1.5	2.74	+ 0.01						
=	434.5	7.7							7.7	2.7	<b>9.</b>						
8	436.7	0.2	•						<b>7.</b>	2.2	<b>4 0.01</b>					-	
2	458.7 -	-1.8 -2.2	200	<b>7.</b>	3.11	168.9	1.2	<u></u>				STATE STATE	16190	13200	14.100	27. 27. 20. 20.	. 907
2	459.2	-2.3							•••••••••••••••••••••••••••••••••••••••	<b>2.</b> 3	٠ 0.01					•	
3	459.4	-2.5							2.7	1.7							
3	4.1.4	-4.7							3.4	2.7	¢ 0.01						

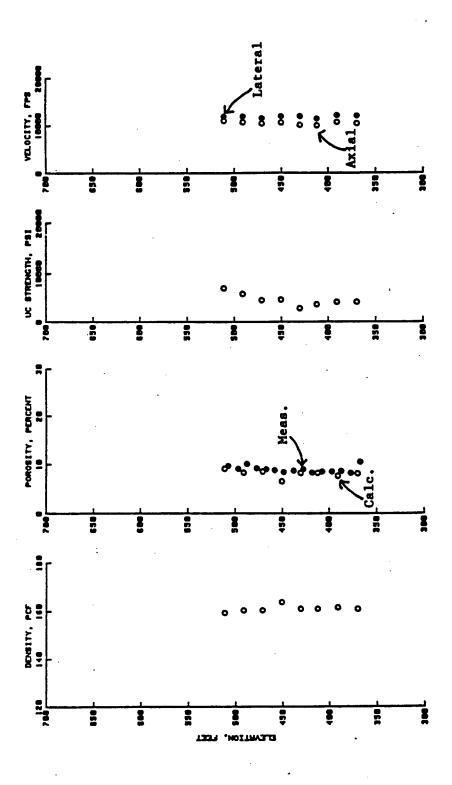
Table 4.2f (page 6 of 6)

PORT DOCK, KERTUCKY - BOCK TEST REBULTS
WAY 7, 1991
(continued)

														BONIC VELOCITIES (FT/REC)	SITIES	(71/16)	
									3						LATTER		
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SAVIE RINBER	21.73 <b>0</b>			THE PAYMENT	MODITION X		SOUTER	WIER CALCULATED CONTENT PORDETTY**	TOROS IT	22		ă E	AKIAL	AVERAGE			
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53	445.0	÷							7.6	2.7	S						
23	33		000	8.0	7.7	167.4	5.2	5.9				SIMIL	25400	13500	140	<u> </u>	25.25 25 25 25 25 25 25 25 25 25 25 25 25 2
*	£	-11.4	٠						5.7	8.8	* 0.01						
3	473.2	-16.3					•		3.3	E.3	4 0.01						
2,	476.1	-19.2	•						2.8	2.2	8.6						
3	478.0	·a.1	•			٠			2.3	<b>2.</b> 3	<b>.0.0</b>						
2	7.047	:0.5							3.5	2.7	8.8						
2	33 2.6		1700	0.X	4.57	149.2	6.0	••				USST/ STALLE	1770	12800	25 88 88	223 883 883	83 88
169	442.4	:8.5							3.6	£.	¢ 0.01				• .		
Ş	6.534	-28.1							:	2.7	× 0.01	•					•
2	<b>18.</b> 4	-31.5							4.3	2.2	× 0.01						
2	1.067	·13.4							3.4	2.7	¢ 0.01						
2	473.0	-34.1							2.0	2.7	÷ 0.0	,					
748	496.5	-39.4							:	2.7	¥ 9:01						
ĸ	<b>1.8.</b> 3	41.3							3.1	2.7	4 0.01			•			•
3	479.5	-42.4							<b>3.3</b>	<b>2.</b>	٠ 0.01						
2	. 28.7 58.1.1	-42.5	808	6.23	N.09	<b>1</b> .7	1.2	. 5:1					14200	13600	903 907 907 907 907	350	
*	500.5	-43.3							Ξ	2.73	9.						
E	502.0	-45.1				•			3.0	2.7	4 9.01						
2	504.5	47.4							7	2.7	€ 0.01					-	
	ST 0111 For	T TAYER TO I	341114														

+ SPECIMEN MAR NOT TAKEN TO FAILURE. • SPECIMEN MAD PATEET MONIZORIAL FLACTURE. •• ALENNED VALLES OF EFECIFIC GRAVITY WERE: SHALE = 2.70 (2.40 FOR NEW ALENATY); LIMESTONE = 2.71; DOLONITE = 2.62; SANDSTONE = 2.45.

Figure 4.1 Summary of Laboratory Test Results for Rock Cores from Boring CB-1, Ft. Knox, KY



Summary of Laboratory Test Results for Rock Cores from Boring CB-3, Ft. Knox, KY

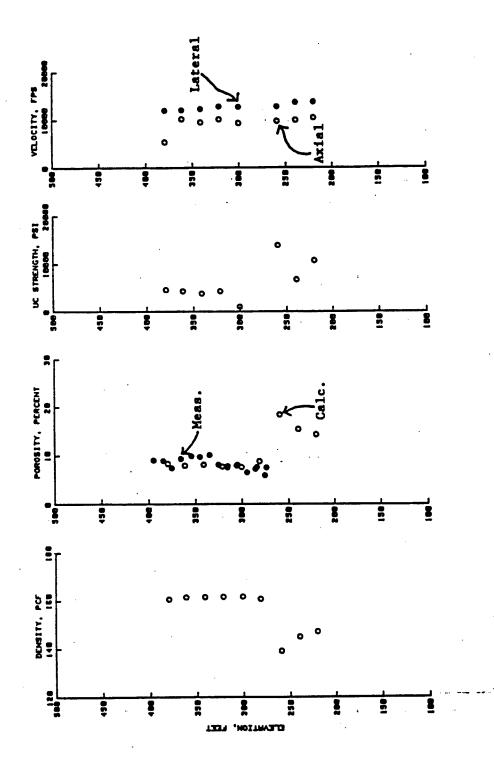


Figure 4.3 Summary of Laboratory Test Results for Rock Cores from Boring CB-4, Ft. Knox, KY

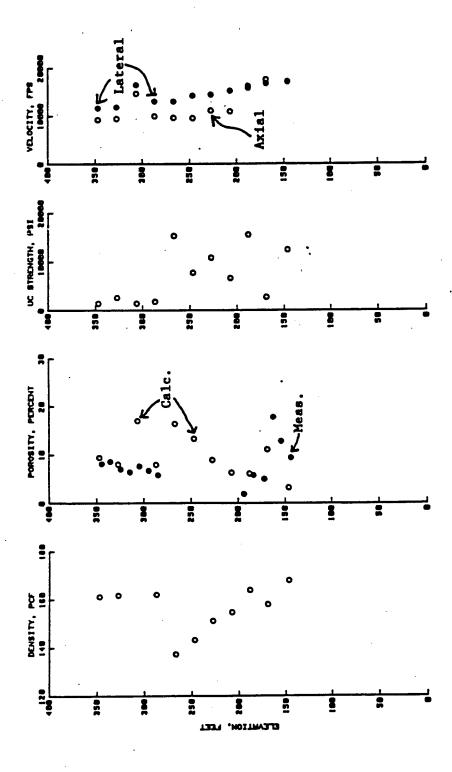


Figure 4.4 Summary of Laboratory Test Results for Rock Cores from Boring CB-5, Ft. Knox, KY

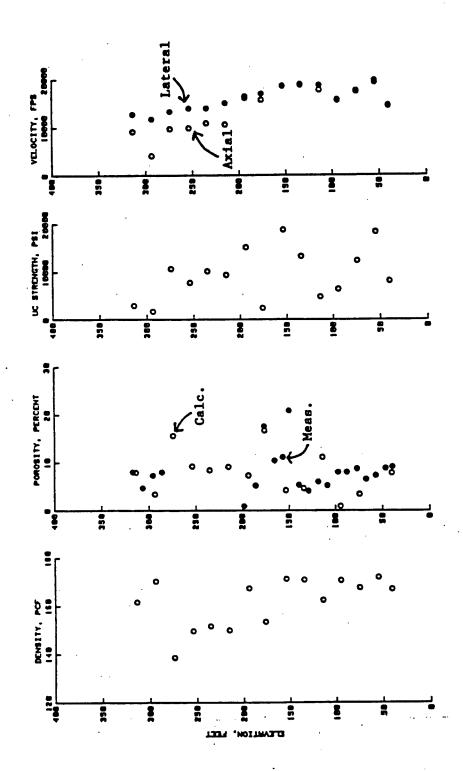


Figure 4.5 Summary of Laboratory Test Results for Rock Cores from Boring CB-6, Ft. Knox, KY

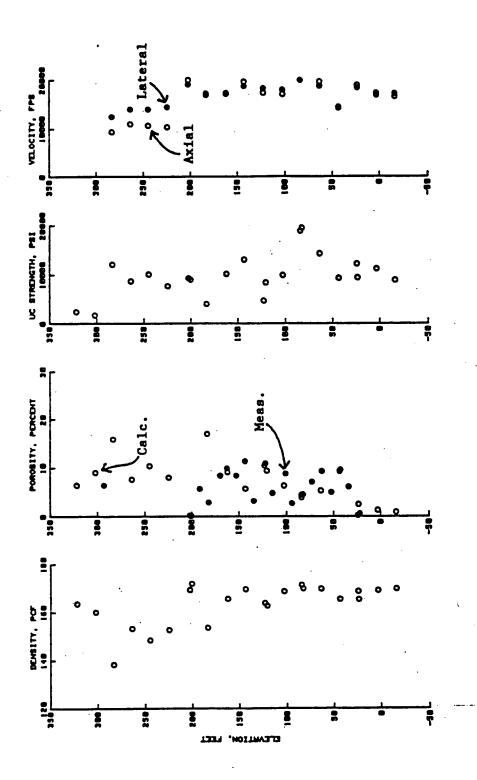


Figure 4.6 Summary of Laboratory Test Results for Rock Cores from Boring FK-1, Ft. Knox, KY

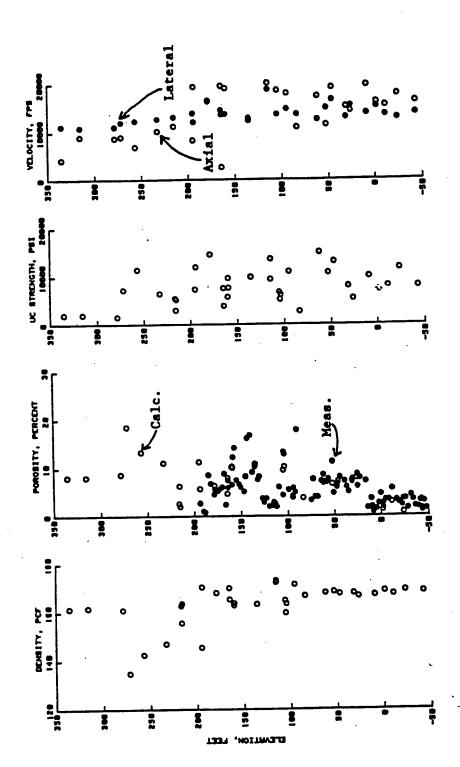


Table 4.3

SUMMARY OF RESULTS OF TENSILE TESTS ON SHALE CORES
FROM UTP BORINGS CB-1, CB-3, AND CB-4 (UPDATED 6/17/91)

Boring No.	Depth (feet)	Dia. (in.)	Ht (in.)	Load (lbs)	Weight (grams)	Wet Density (pcf)	Water Content (%)	Dry Density (pcf)	Indirect Tensile Strength (psi)	Direct Tensile Strength (psl)
~ ·	175.65	1.762	0.964	1506	97.42	157.9	4.23	151.5	564.4	_
<b>CB-1</b>	190.80	1.763	0.961	1007	96.91	157.4	4.15	151.1	378.4	-
	206.00	1.760	1.028	980	104.53	159.2	4.23	152.8	344.8	-
	220.35	1.759	0.967	908	96.97	157.2	4.05	151.1	339.8	
	265.45	1.760	0.959	608	96.71	157.9	4.54	151.1	229.3	-
	279.85	1.762	1.000	599	102.05	159.4	4.67	1523	216.4	-
	279.95	1.757	0.982	808	100.19	160.3	4.24	153.8	298.1	-
	285 <i>.5</i> 0	1.757	0.933	890	95.63	161.0	3.59	155.5	341.8	-
	291.55	1.756	0.989	735	100.68	160.1	3.75	154.3 153.2	269.4 251.7	_
	294.10	1.761	0.938	633 363	95.43 95.41	159.1 160.2	3.85 4.11	153.9	294.1	_
	295.25	1.751	0.942 0.977	762 626	95.41 99.22	159.6	4.12	1333	232.2	_
	299.65 304.70	1.757 1.759	0.978	494	103.39	165.7	3.68	159.8	182.8	_
	309.50	1.763	0.575	662	89.99	158.3	4.39	151.7	269.5	-
	309.60	1.759	1.000	708	101.58	159.2	3.78	153.4	256.2	_
	347.54	L.133								
CB-3	330.40	1.748	0.941	1134	94.22	158.9	4.22	1525	438.9	-
-	345.05	1.762	1.005	1171	102.31		., 4.30	152.5	421.0	-
	360.00	1.763	0.969	1180	97.66	157.3	4.62	150.3	439.7	_
	374.85	1.759	0.992	1370	100.73	159.2	4.48	152.4	499.8	-
	390.10	1.759	1.002	1624	102_58	160.5	4.34	153.8 150.9	586.6 274.4	-
	405.05	1.762	0.956	726 563	96.39 89.19	157.5 160.8	4.38 4.28	154.2	230.2	_
	411.50 414.80	1.728 1.758	0.901 0.989	1071	101.14	160.5	4.32	153.9	392.2	_
	420.25	1.761	1.062	1271	109.65	161.5	3.91	155.4	432.7	-
	425.50	1.761	0.953	1162	97.83	160.6	4.58	153.5	440.8	-
•	430.40	1.759	1.035	1198	106.18	160.8	4.42	154.0	418.9	<u>-,</u>
	435.50	1.760	1.070	1316	108.72	159.1	4.30	152.5	444.9	
	440.60	1.762	0.979	2949	82.56	131.8	1.99	129.2	1088.3	-
	445.10	1.763	1.005	2931	93.67	145.5	1.30	143.6	1053.1 1320.5	_
	450.70	1.765	1.056	3866	95.18	140.3	1.10 2.01	138.8 148.9	748.1	_
	465.05	1.763	1.003 0.961	2078 2514	97.63 88.37	151.9 143.7	212	140.7	945.2	_
	479.40	1.762	0.701	217	90.31	1401		210.7	,,,,,	
CB-4	366.60	1.865	1.000	944	114.27	159.4	4.26	152.8	322.2	-
	380.15	1.864	0.998	1125	114.29	159.9	3.99	153.7	385.0	-
	395.20	1.768	1.005	898	110.07	170.0	3.36	164.4	321.7	-
	409.45	1.762	0.972	1343	99.19	159.4	4.41	152.7	499.2	-
	424.10	1.767	0.994	1143	102.72	160.5	4.61	153.5	414.3	10
	435.00	1.776	4.346	24	453.53	160.5	3.05	155.7 137.0	1227.3	1.0
	439.90	1.773	0.993	3394	89.42 373.31	138.9 133.8	1.40 1.00	132.5	-	1132
	443.52 456.25	1.773 1.772	4.305 4.232	279.4 153.7	393.13	143.5	1.16	141.9	_	62.3
	456.70	1.771	0.957	1815	91.86	148.4	1.75	145.9	681.8	
	461.70	1.770	1.010	2042	96.83	148.4	1.47	146.3	727.2	_
	466.10	1.774	0.989	2006	94.45	147.2	1.40	. 145.2	727.9	-
	470.50	1.773	1.014	2504	99.78	151.8	2.21	148.6	886.7	-
	475 <b>.30</b>	1.769	4.210	257.2	401.06	147.7	1.87	144.9	-	104.6
	475.60	1.770	1.022	2441	97.01	147.0	1.84	144.3	859.1	-
	480.60	1.758	0.987	2405	101.21	160.9	261	156.8	882.4 604.5	-
	486.00	1.770	- 0.940	1815	89.03	146.6	1.83	144.0 145.8	694.5 —	- 95.9
	486.30	1.769	4.139	235.6 2296	396.44 97.02	148.5 155.2	1.85 2.45	151.5	853.1	, <del>.</del>
	491.10	1.770	0.968 4.235	261.7	440.13	161.5	2.70	157.2	-	106.7
	495.85 <b>50</b> 0.00	1.767 1.771	4.235 1.016	2568	M25		2.23	143.3	908.6	-
	J-VVV	4.//1	1.010		14-55			- · · - · ·		

Figure 4.7
Tenisle Strength Tests, Boring CB-1
BORING: CB-1

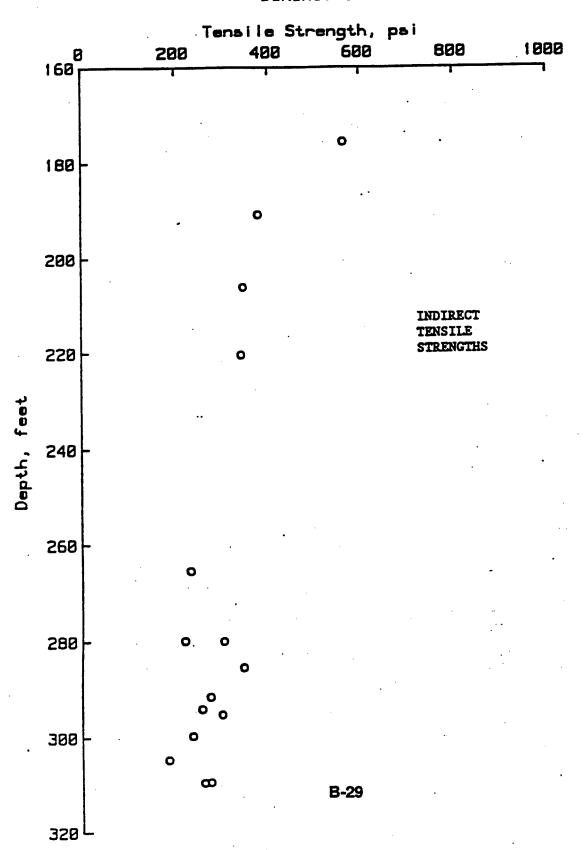
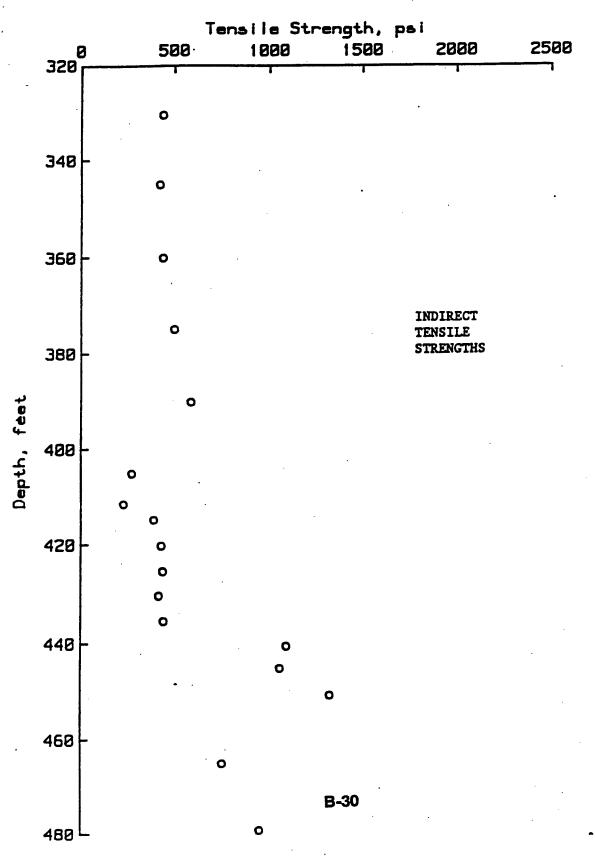


Figure 4.8
Tensile Strength Tests, Boring CB-3
BORING: CB-3



BORING: CB-4

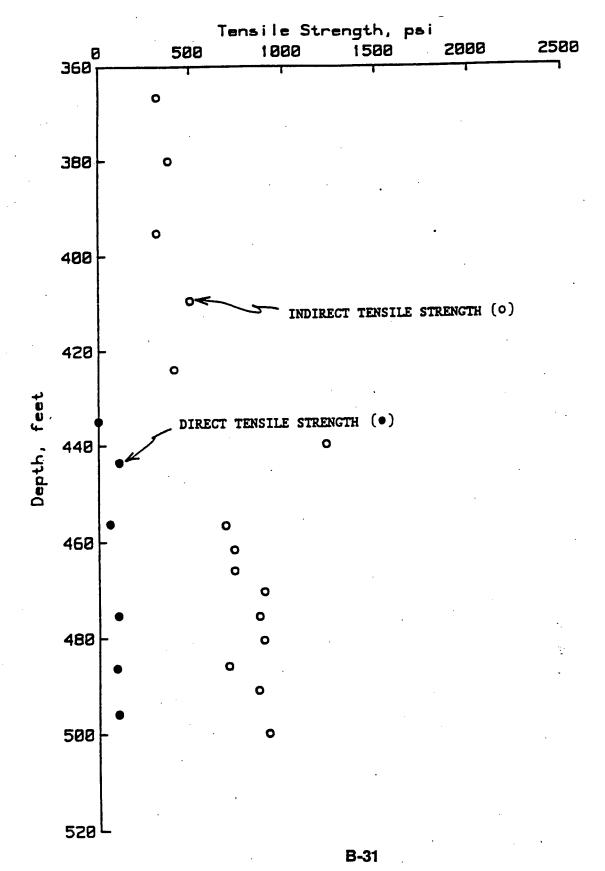


Figure 4.10 Composite Plot of Strength Test Data for CB-1, CB-2, and CB-4

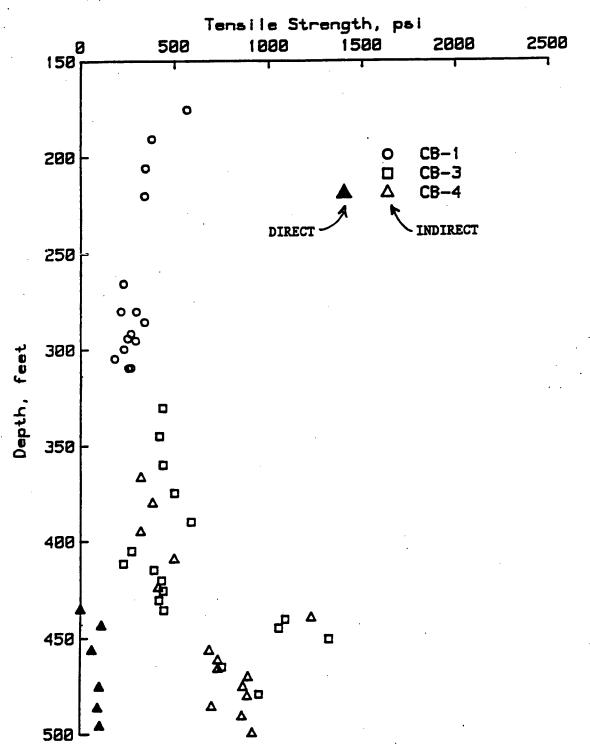


TABLE 4.4

QUANTITATIVE X-RAY DIFFRACTION ANALYSIS

Hole #	Depth (ft)	Formation	Clay-%	Qrtz-%	Fldspr-%	Calc-%	Dolo-%	Other-%+
CB-6	429.9	N. Prov.	5	23	3	<1	5	68
CB-6	453.2	N. Albany	12	19	7	<1	<1	72
CB-6	536.0	Louisville	1	1 .	•	-	98	1
CB-4	426.0	N. Prov.	12	23	7	<1	<1	68
CB-4	460.2	N. Albany	9	28	7	<1	1	62
CB-4	521.8	Jfsnvi	1	1	. •	78	20	1
CB-4	555.5	Louisville	1	2	•	<1	97	1

<sup>&</sup>lt;sup>+</sup> Other represents all "other" material not detected by X-ray diffraction analysis, e.g. organics and amorphous material such as glass

, \_

# Appendix C Geologic Maps

1 L A1	i
Job No.	l No
	 140

Project UTP - Ft . Knox , KY	Computed G. Alsayab	Date
Subject Geological Mapping of Tunnel	Checked	Date
Task	Sheet /	or 72

- \* Geological Mapping was done according to the "Full Periphery Method" which is explained in the Engineer Technical Letter No. 1110 1 37, published by Dept. of the Army Office of the Chief of Engineers Washington, D.C. 2031 and Lated 18 Sept. 1970
- \* In this specific mapping of the UTP tunnel, the assumption that Magnetic Declination @ Ft. Knox, KY is Zero, was utilized and extendation of geologic discontinuities of Lilling plant. encountered was measured in Magnetic Azimuth using a Brunton Compass.
- \* Main Tunnel orientation, prior to curve = 335° Az
- \* Contractor did not maintain station marking along tunnel during excavation. Stations were marked every 100 over shotcrete liner later on.
- \* Whole tunnel is lined with shoterete of 2' thickness minimum.

Scale: 1"= 6' horizontal
1"= 5' Along Tunnel Axis

Legend:

? : Estimated

cave in cast (fell-out)

: Siderite Nodule or cast

O or □: Rock dowel

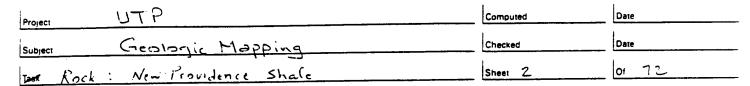
□ : Tensioned Pock BoH

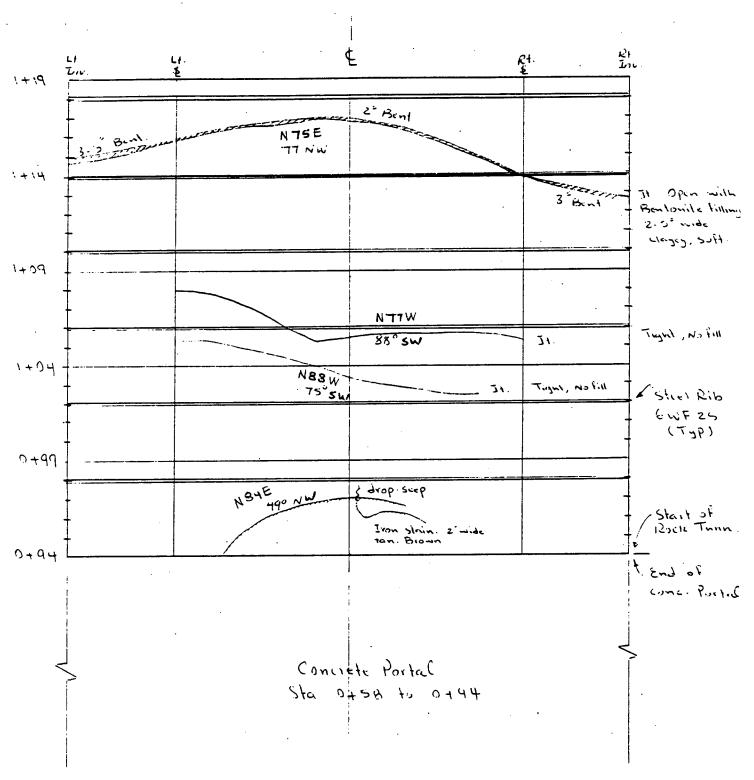
8 : Scepage

+++++ : Staining

Filling Material

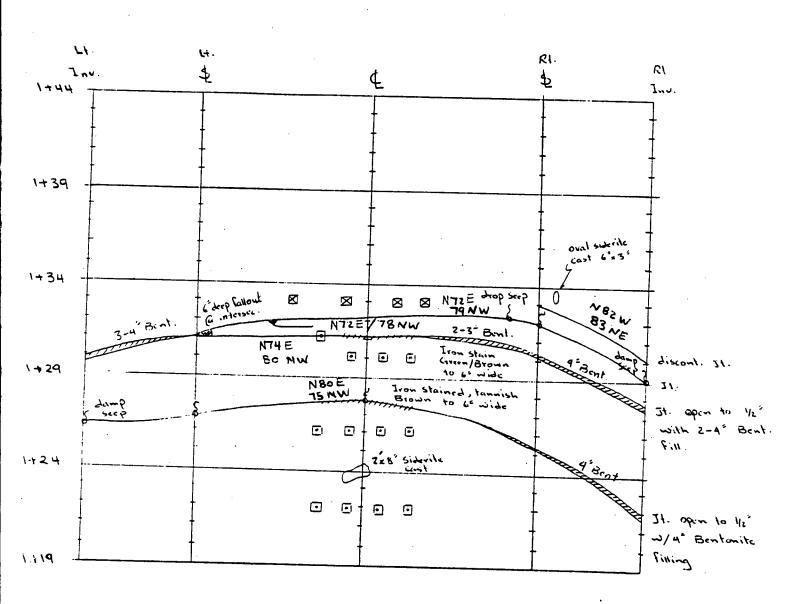
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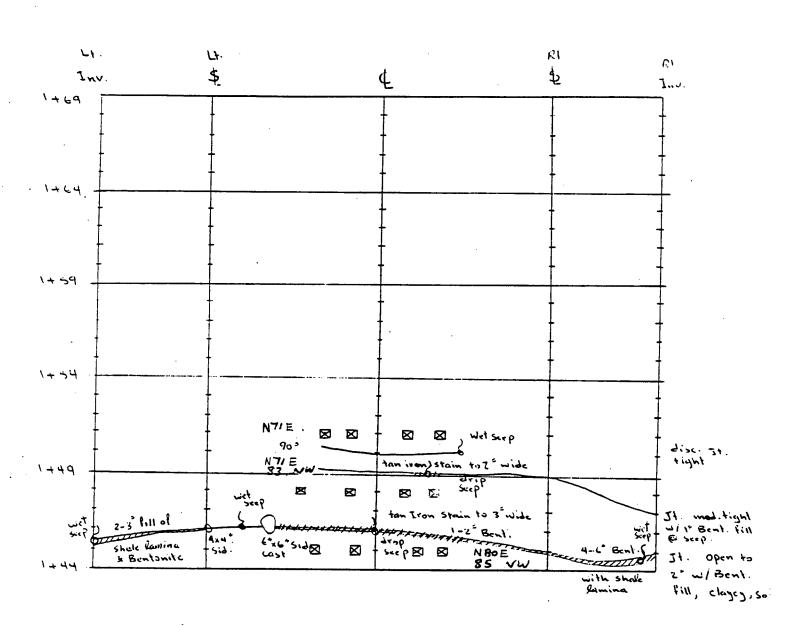
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Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Took Rock	: N.P. Shale	Sheet 3	01 72

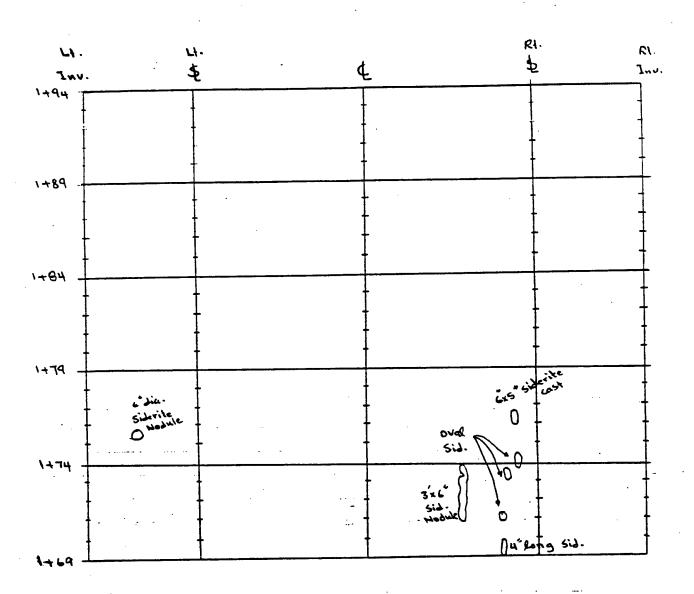


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Project	UTP		Computed	Date
Subject	Geologic Mapping		Checked	Date
Task	Rock: New Providence	Shale	Sheet 4	of 72

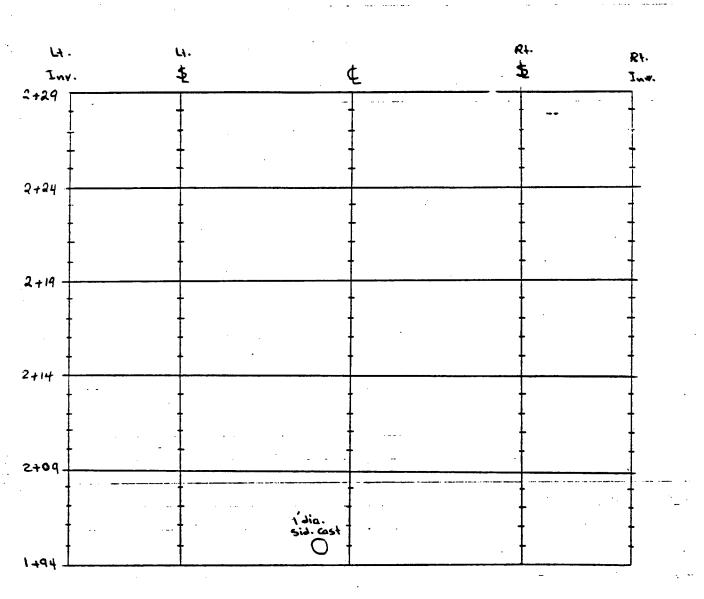


Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: N.P. Shale	 Sheet 5	or 72



Massive Rock No Joints

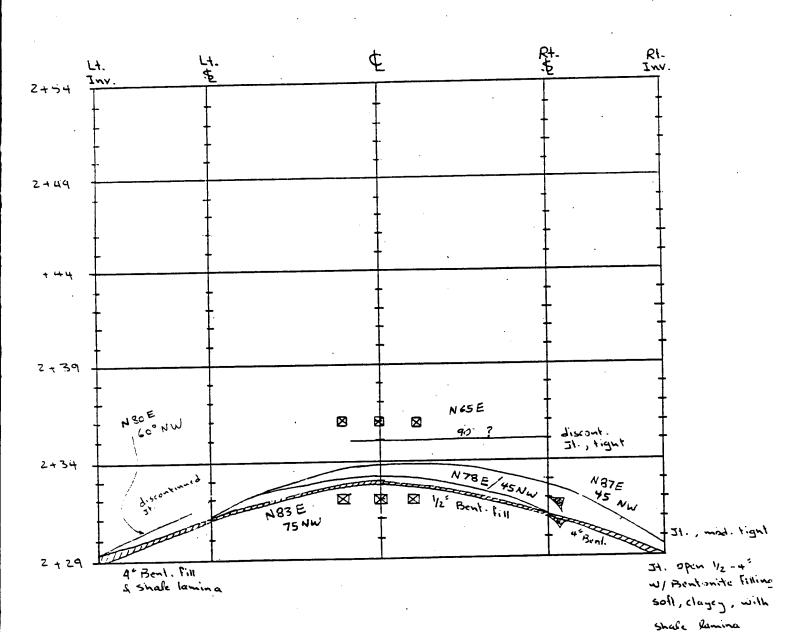
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Subject	Geologic Mapping	Checked	Date
Took	Rock: New Providence Shale	Sheet 6	01 72



Massive Rock No discontinuities

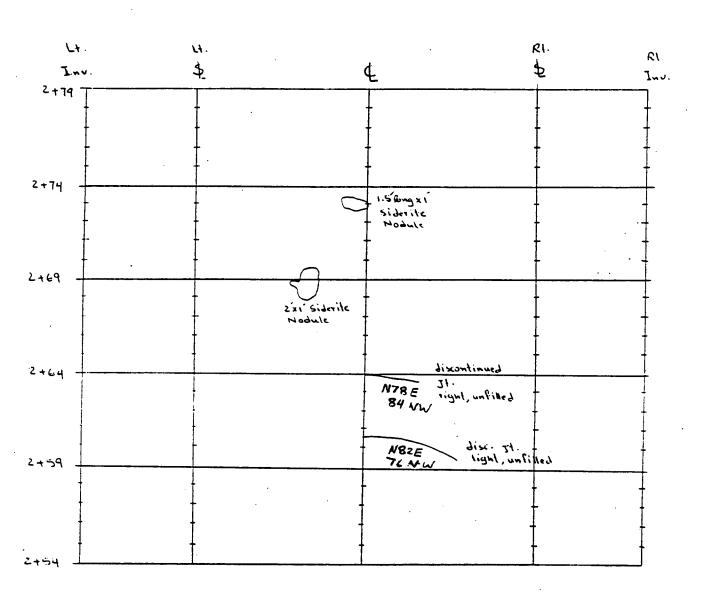
Job No	No
J00 NO.	

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet 7	01 72

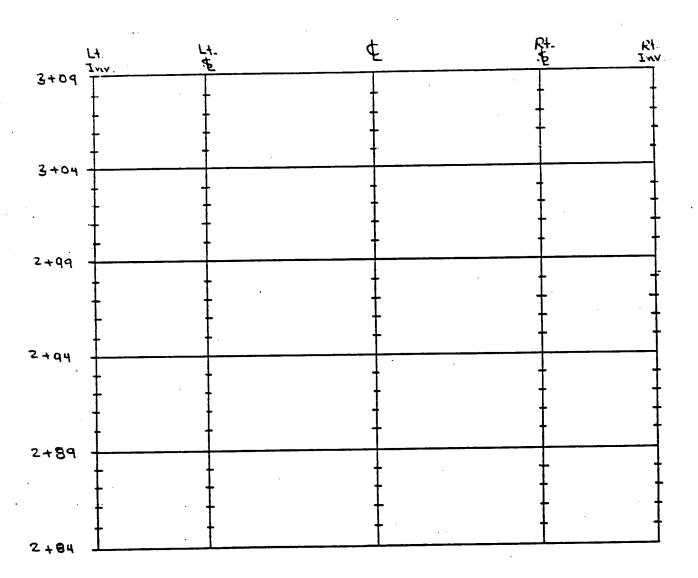


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Taux	Rock: N.P.	shale	Sheet 8	01 72

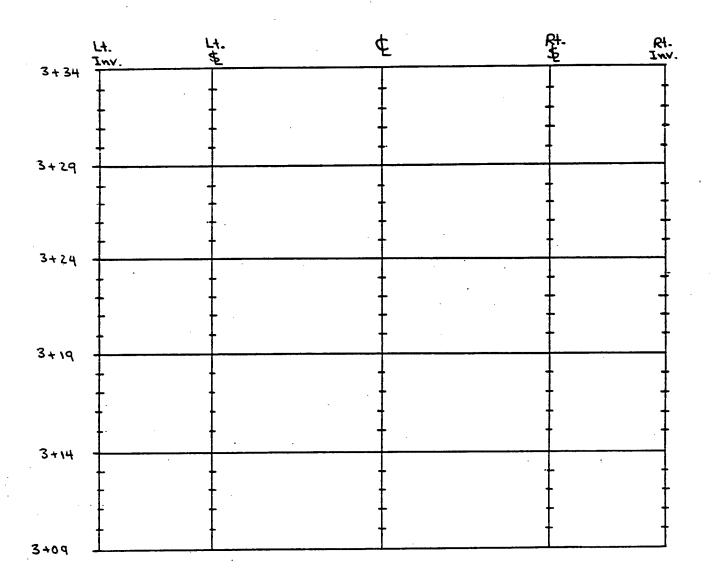


Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet q	01 72



Massive Rock No discontinuities

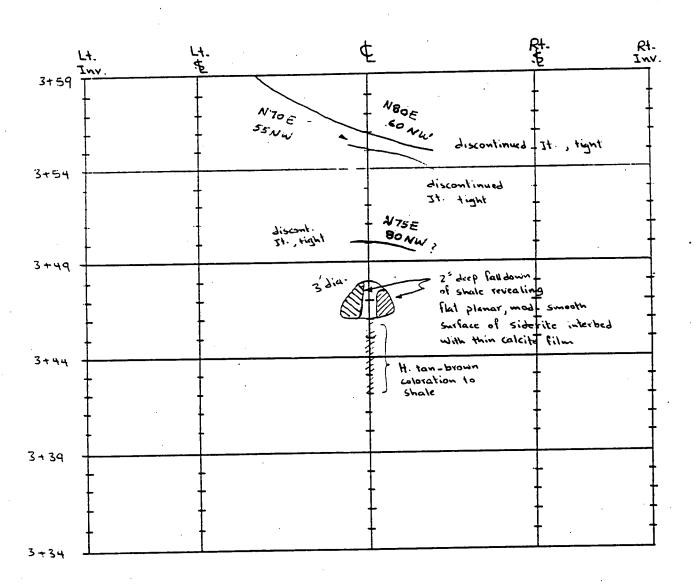
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Subje	ct				Checked	Date
Task	Rock:	New	Providence	shafe / contamons	Sheet 10	01 72



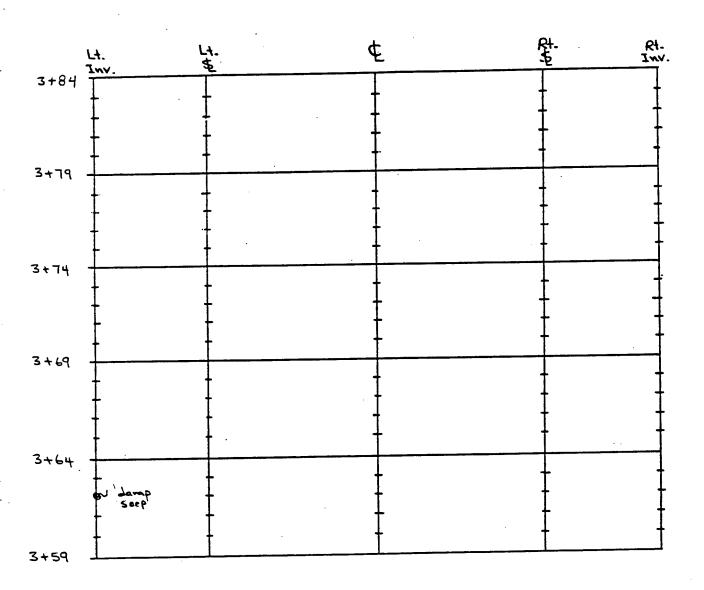
Massive New Providence Shale formation with no discontin.

Job No.	 	_	1100

Projec	UTP					Computed	Date
Subje	ct					Checked	Date
Task	Rock: New	Providence	Shale	/	cottonean	Sheet \\	Of 72

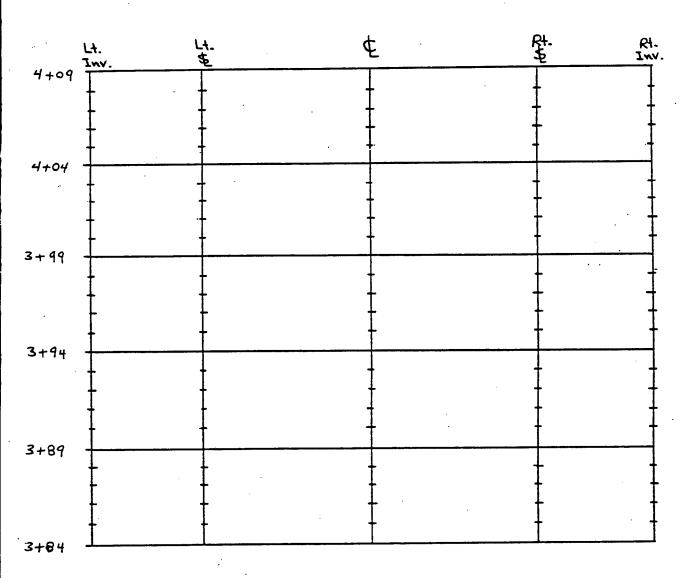


Project	UTP	Computed	Date
Subject		Checked	Date
Task R	ock: New Providence shale / commonan	Sheet 12	01 72



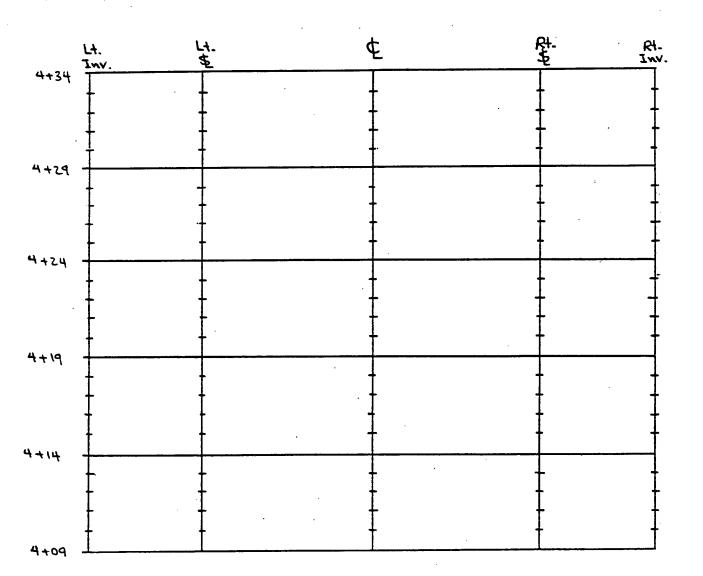
Massive Rock W/no Joints

	Project UTP	Computed	Date
•	Subject	Checked	Date
	Took : New Providence shale / waters	Sheet 13	01 72



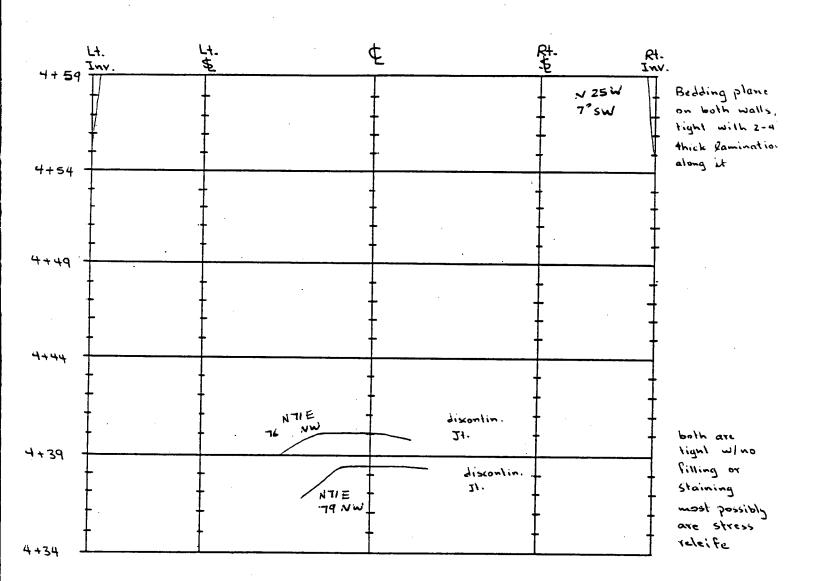
Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Test Rock: New Providence Shale	Sheet 14	or 72

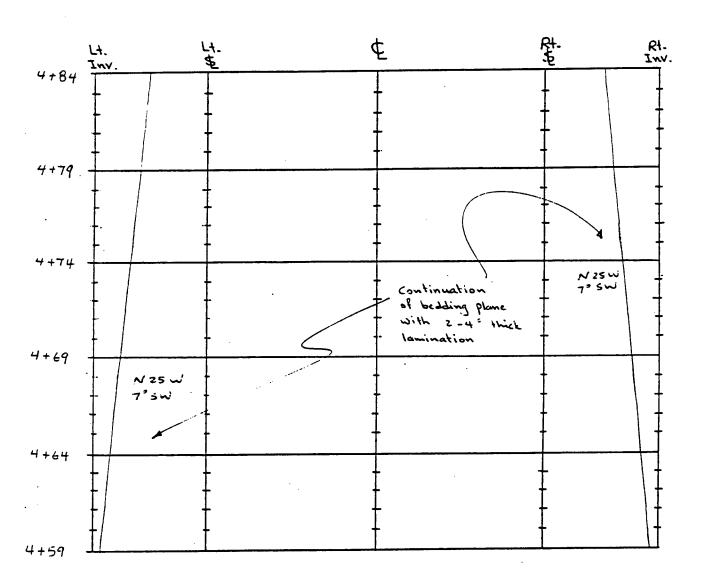


Massive Rock

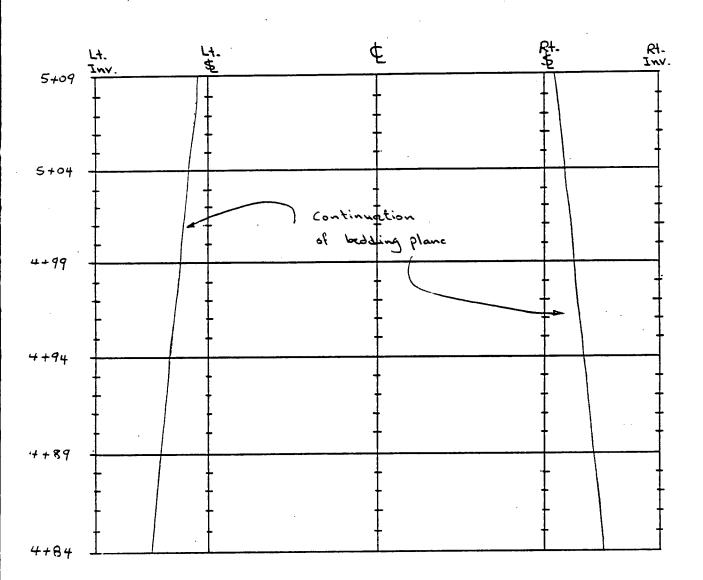
Project UTP	Computed	Date
Subject	Checked	Date
Took : New Providence Shale	Sheet \5	or 72



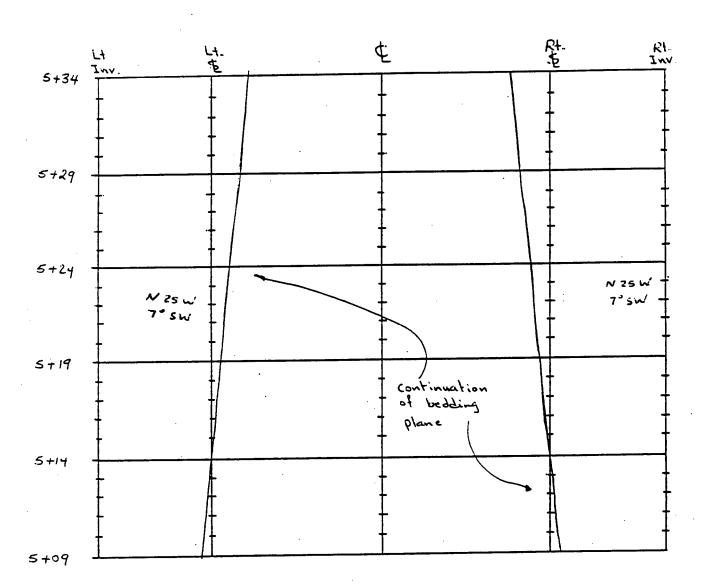
Project	UTP				Computed	Date
Subjec	t				Checked	Date
Task	Rock:	New Providence	Shale	/ edumenas	Sheet 16	or 72



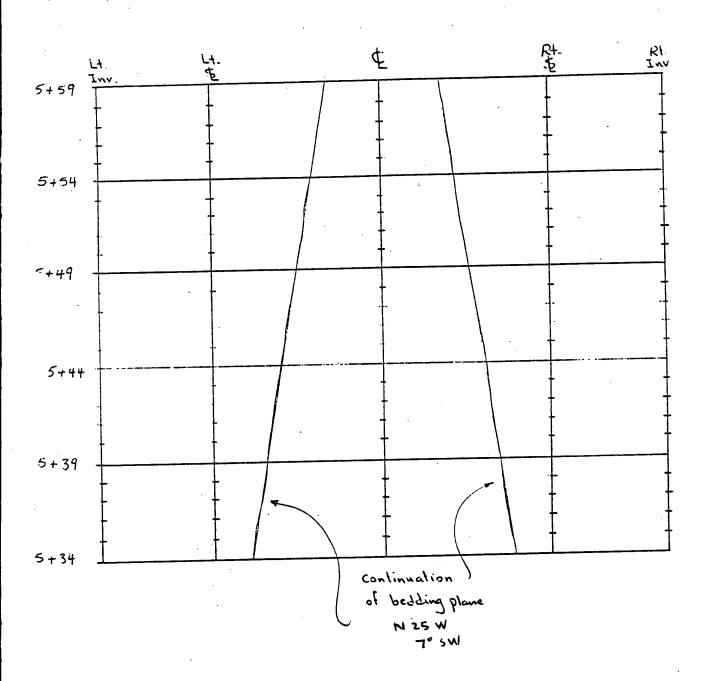
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Subject			Checked	Date
Tack	Rock: New Providence Shale	/ Gatoaneous	Sheet 17	of 72



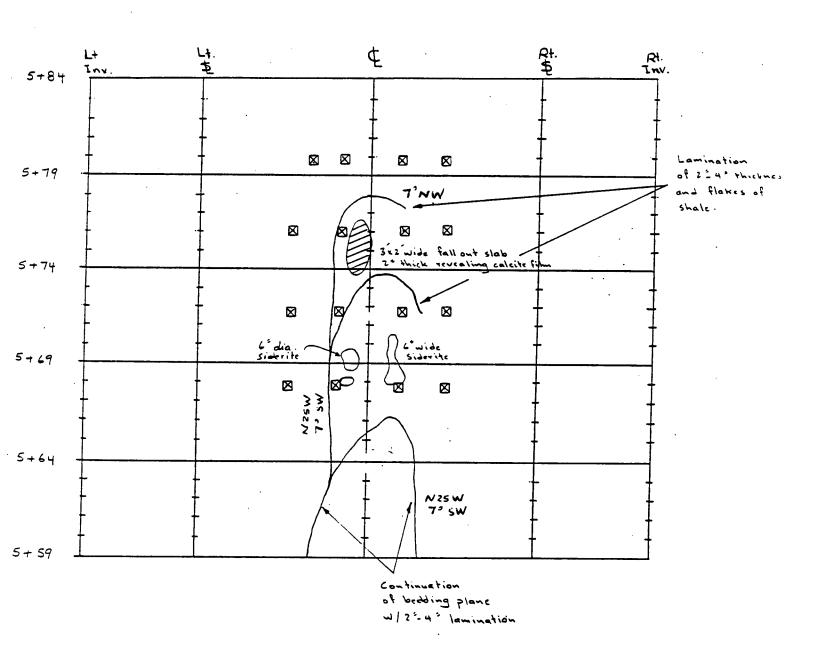
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Subject	Geologic Mapping	Checked	Date
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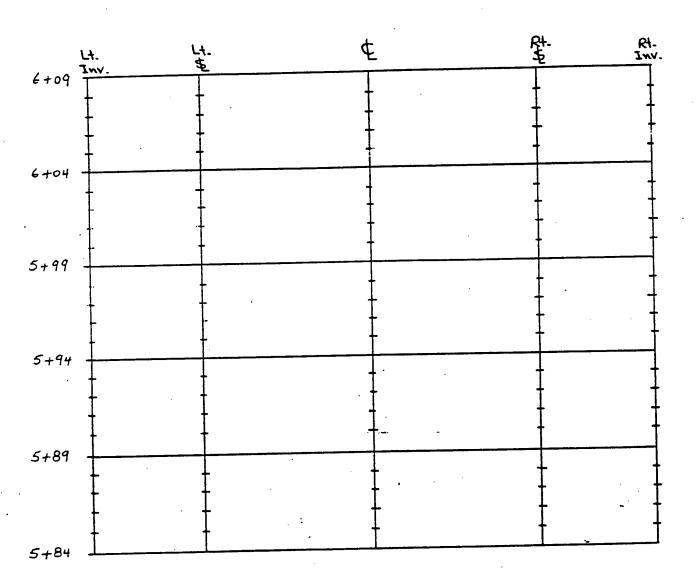
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Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence shale / rahearesto	Sheet 19	01 72



 Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Took Rock: New Providence Shale	Sheet ZO	of 71

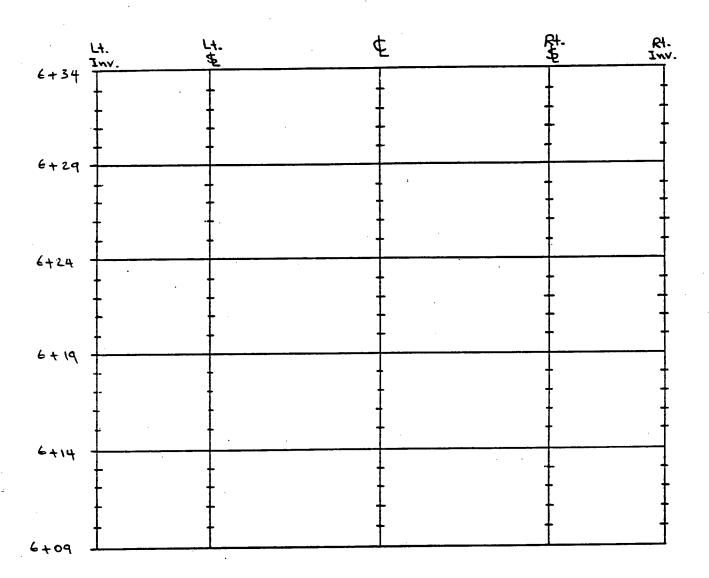


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Subject	Geologic Mapping		Checked	Date
Task	Rock: New Providence	Shale / entransans	Sheet ZI	of 72



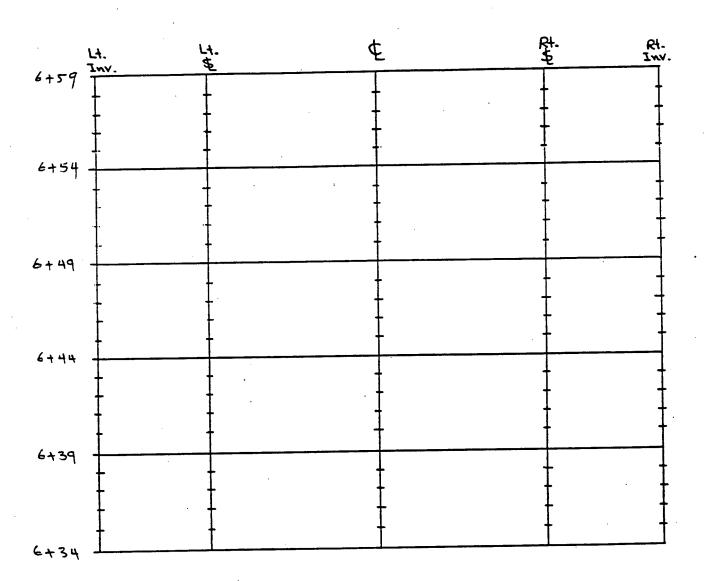
Hassive Rock
W/no Joints

Project	UTP	عا ۔	computed	Date
Subject	•	ے اِ		Date
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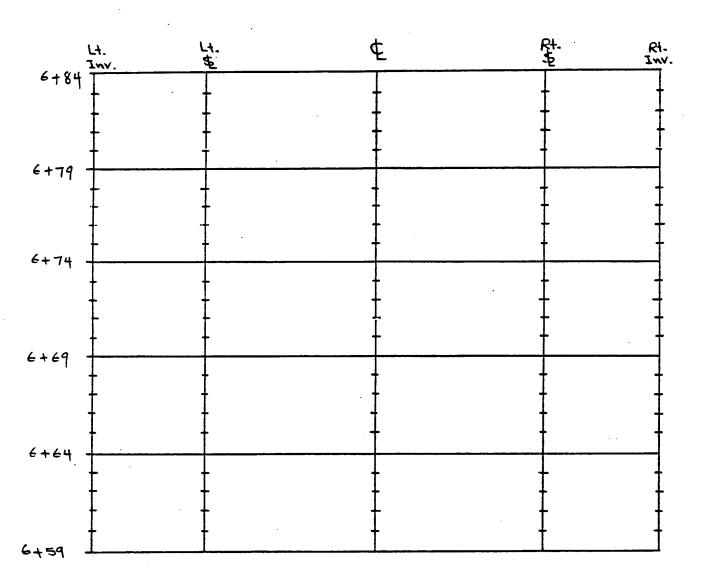
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Subject	Checked	Date
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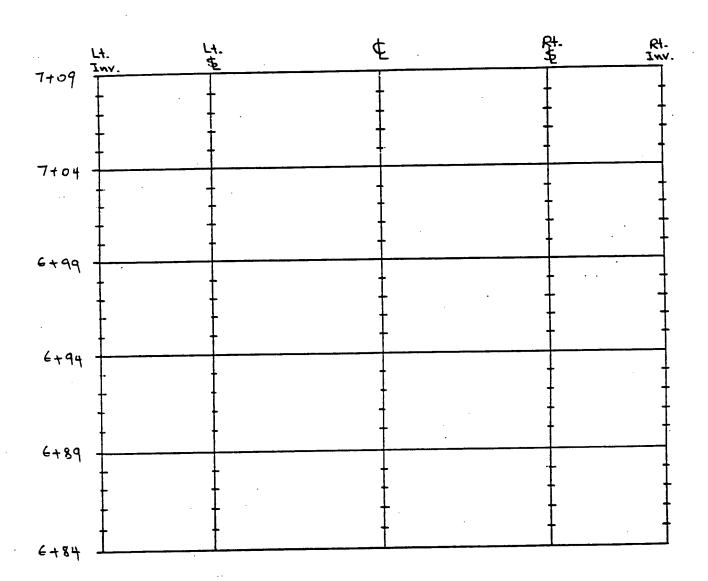
Massive Rock No Joints

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Subject		Checked	Date
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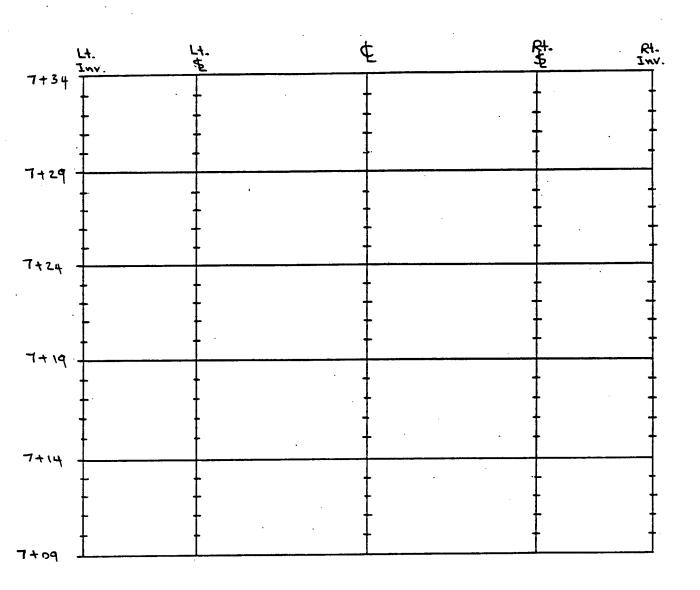
Massive Rock No Joints

Project UTP		Date
1	-	Date
	Sheet 25	01 72



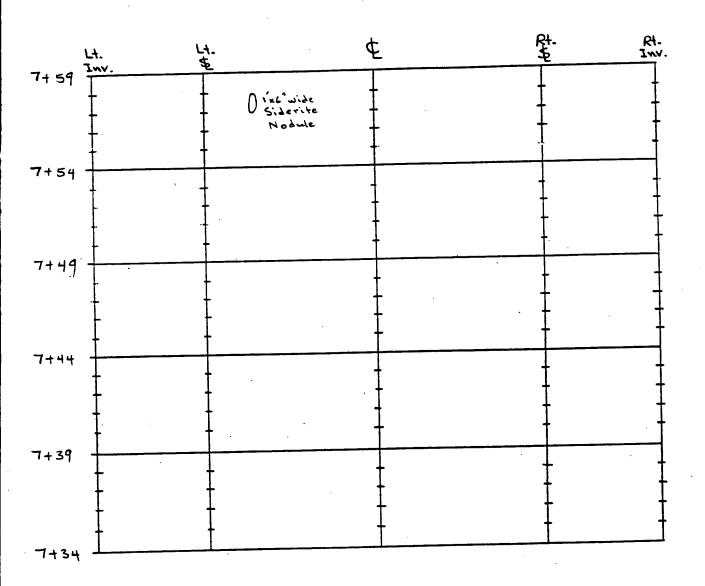
Massive Rock No Joints

Project	UTP	Computed	Date
Subject		Checked	Date
Task Roc	k: New Providence shale / advantages	Sheet 26	01 72



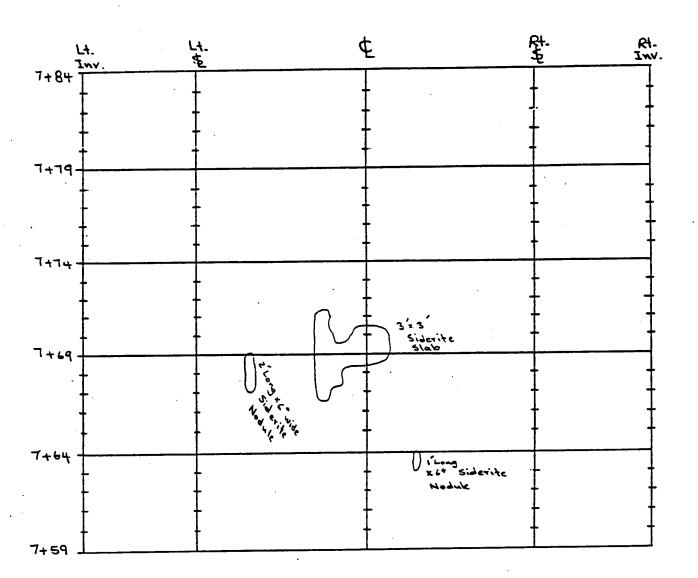
Massive Rock No Joints

Project UTP	1	Date
	Checked	Date
Test Rock: New Providence Shale / water	Sheet ZT	or 72



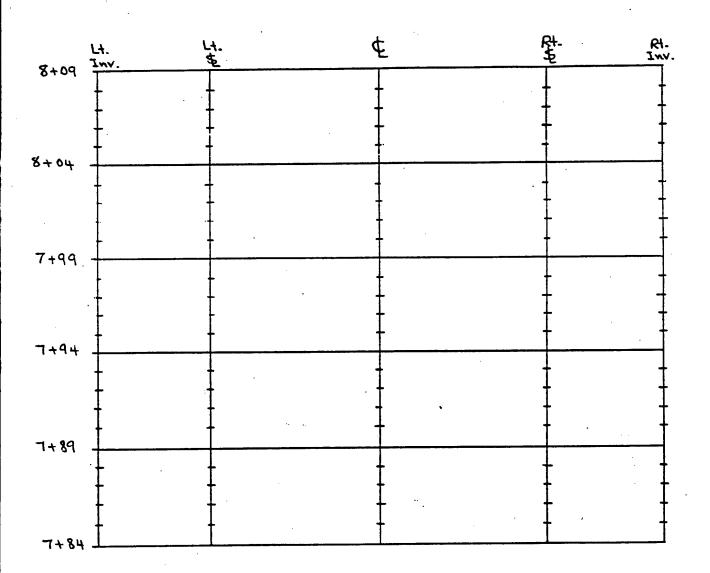
Massive Rock No Joints

Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 28	01 72

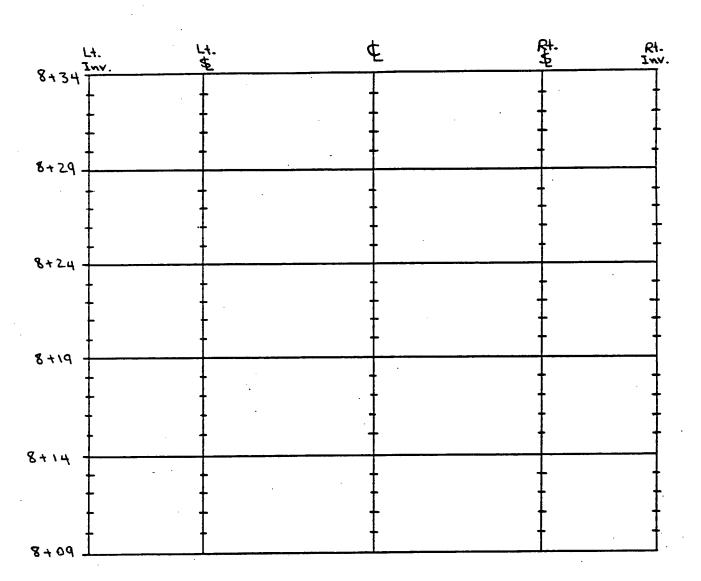


Massive Rock

Project UTP	Computed	Date
	Checked	Date
	Sheet 29	01 72

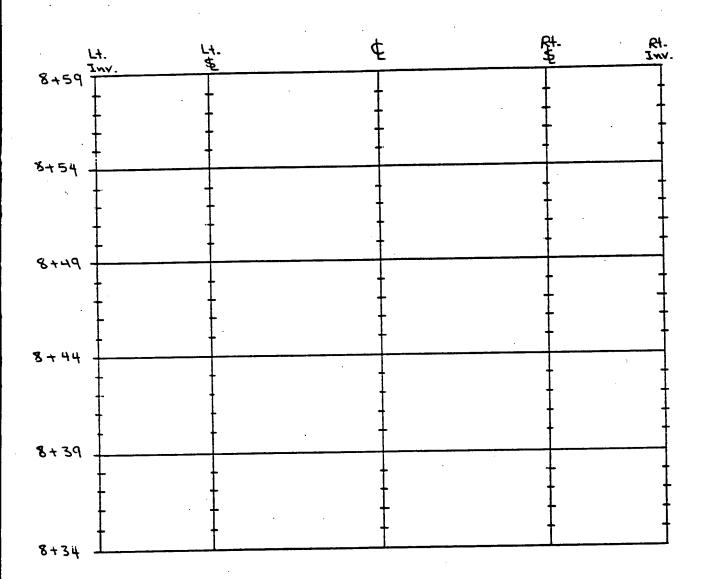


Project	UTP	Computed	Date
Subject		Checked	Date
Tank Rock	: New Providence Shale	Sheet 30	or 72

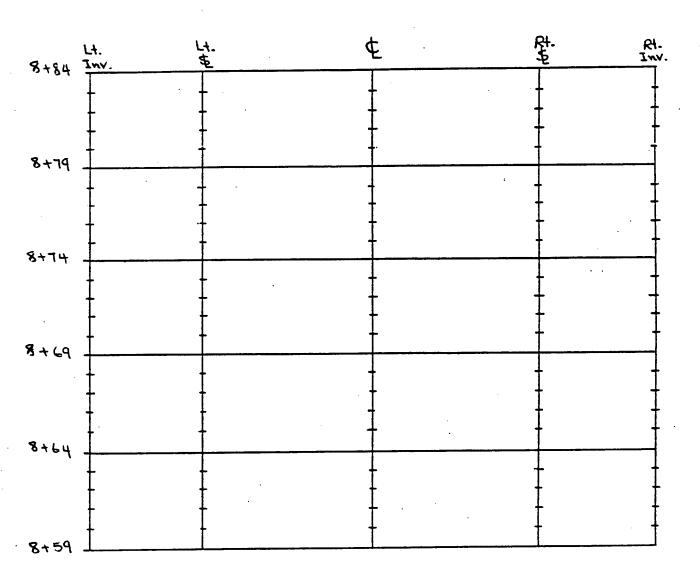


Massive Rock

Project UTP	Computed	Date
	Checked	Date
Subject  Tod Rock: New Providence Shale	Sheet 31	or 72

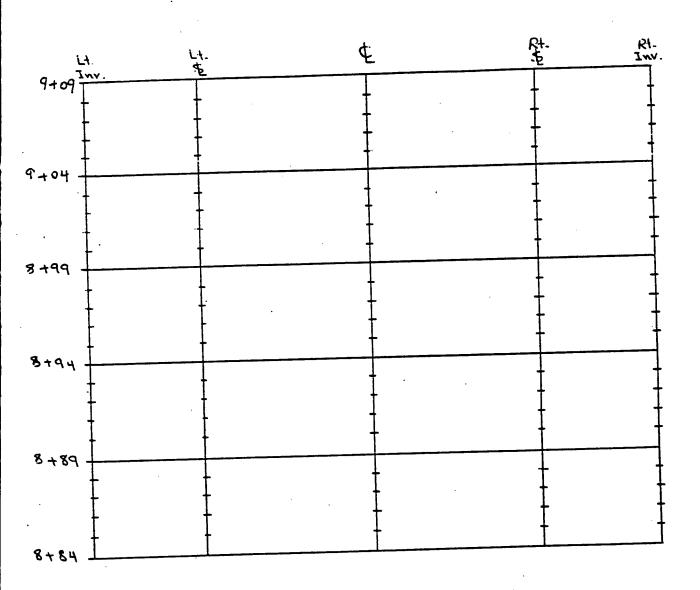


Project UTP	Computed	Date
Subject	Checked -	Date
Took Rock: New Providence Shale	Sheet 32	01 72

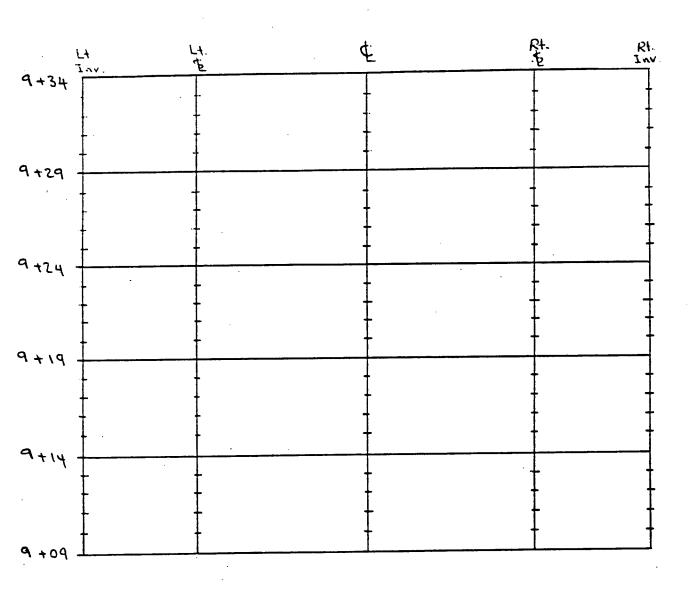


Massive Rock

Project UT	Ρ	Computed	Date
Subject		Checked	Date
Took Rock:	New Providence Shale	Sheet 33	01 72

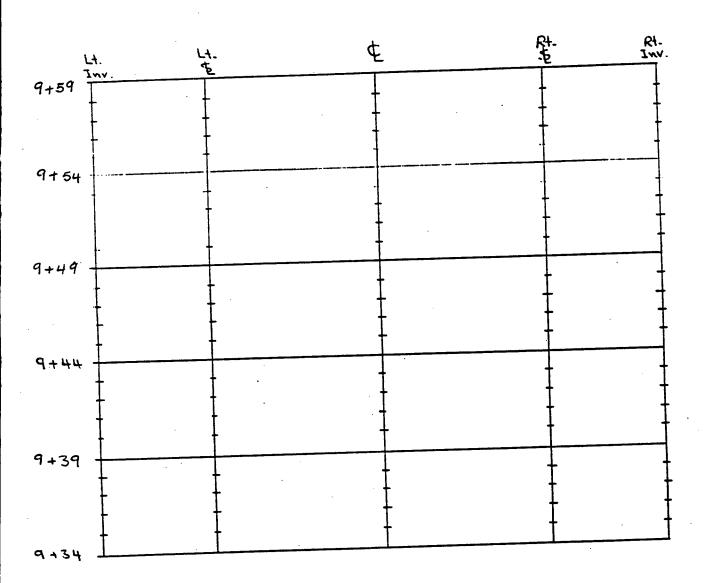


Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale	Sheet 34	01 72

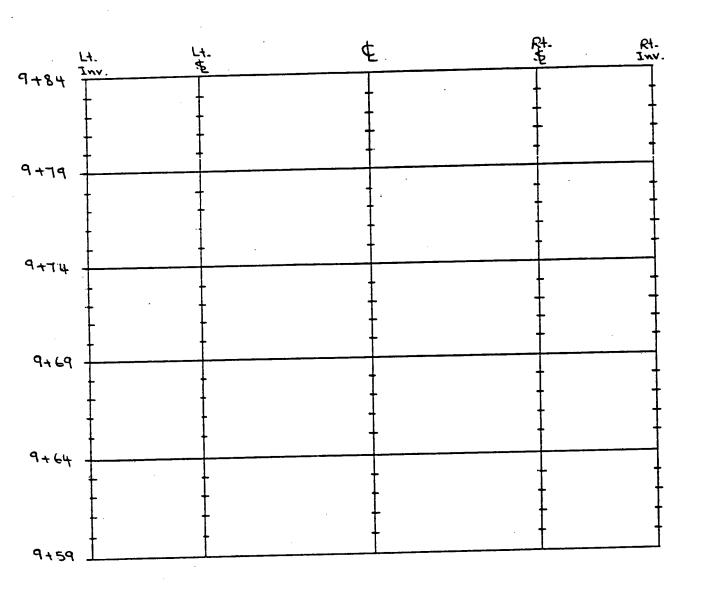


Massive Rock

Project UTP	Computed	Date
	Checked	Date
•	Sheet 35	01 72

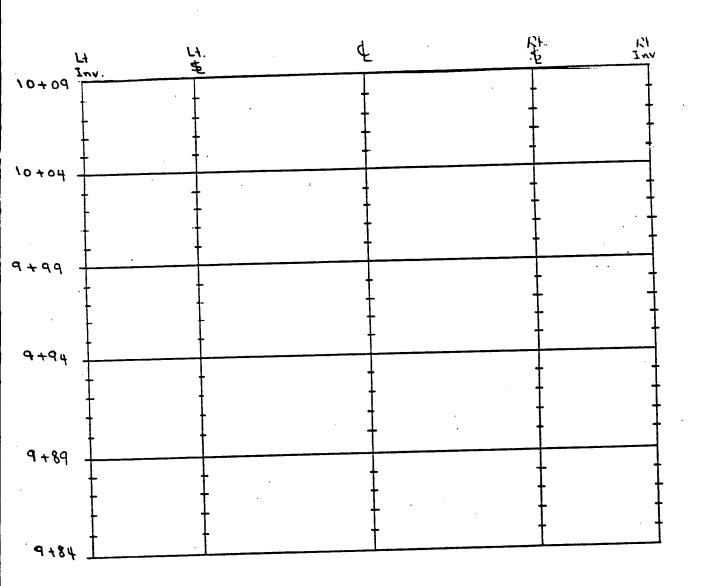


Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 36	or 72

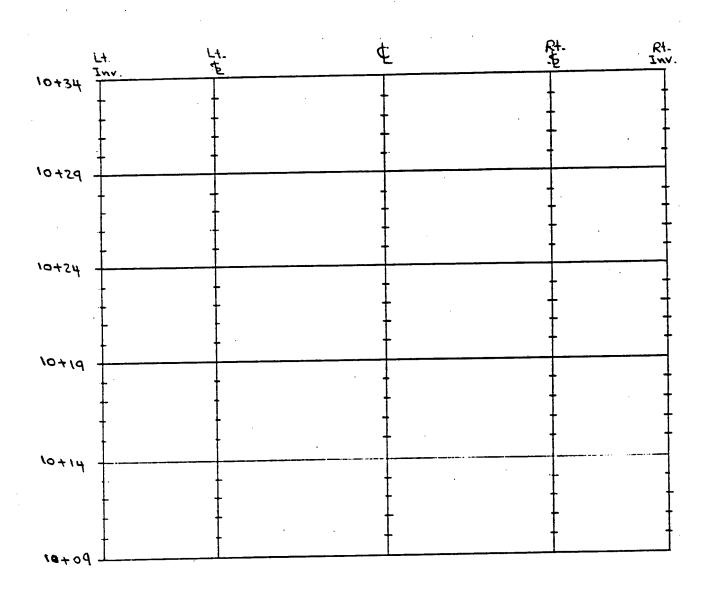


Massive Rock

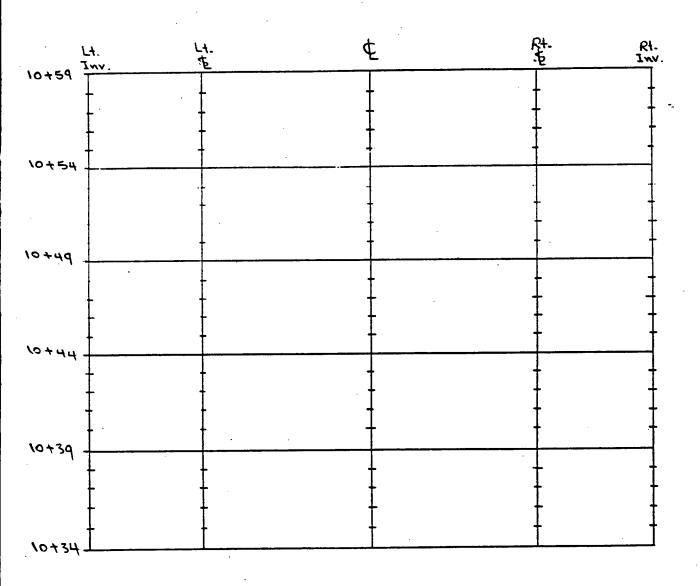
. Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 37	or 72



Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 38	01 72

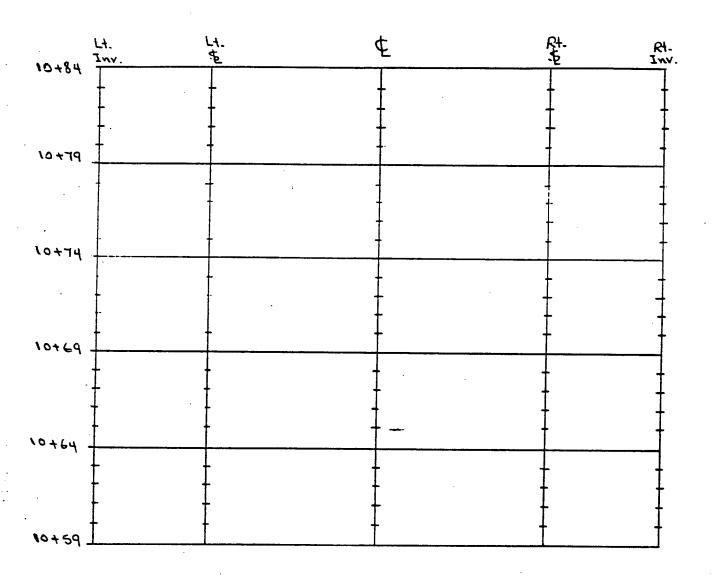


Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Providence shale	Sheet 39	01 72

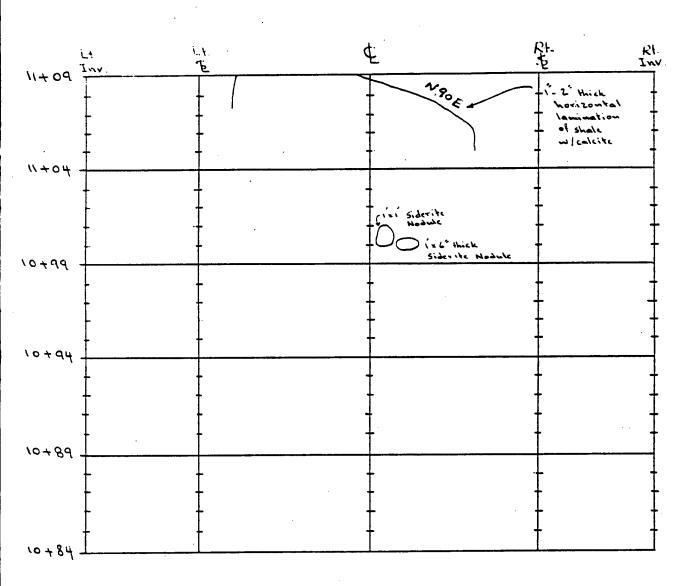


Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Task Pack: New Providence Shale	Sheet 40	01 72

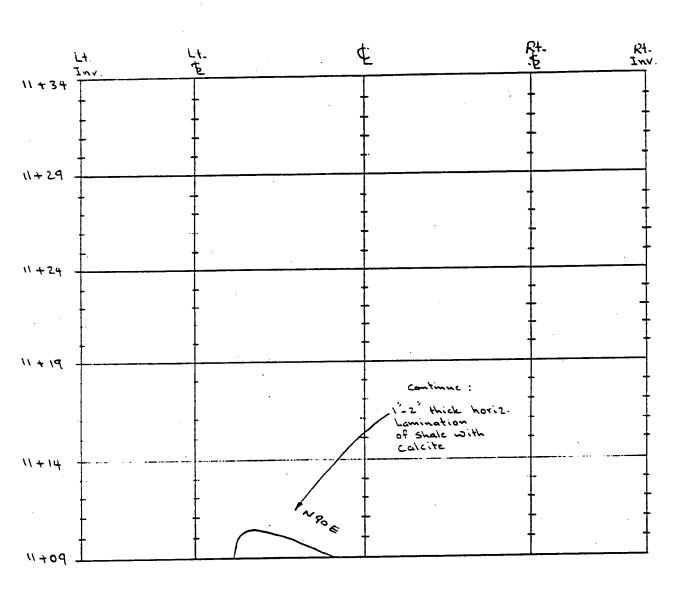


Project		UTP		Computed	Date
Subject	•			Checked	Date
Task	Rock N	Vew Providence	Shale	Sheet 41	01 72

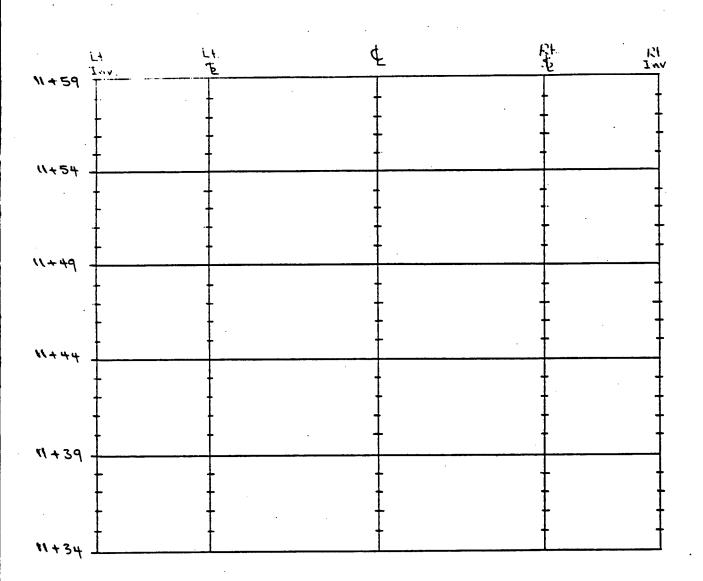


Massive Rock

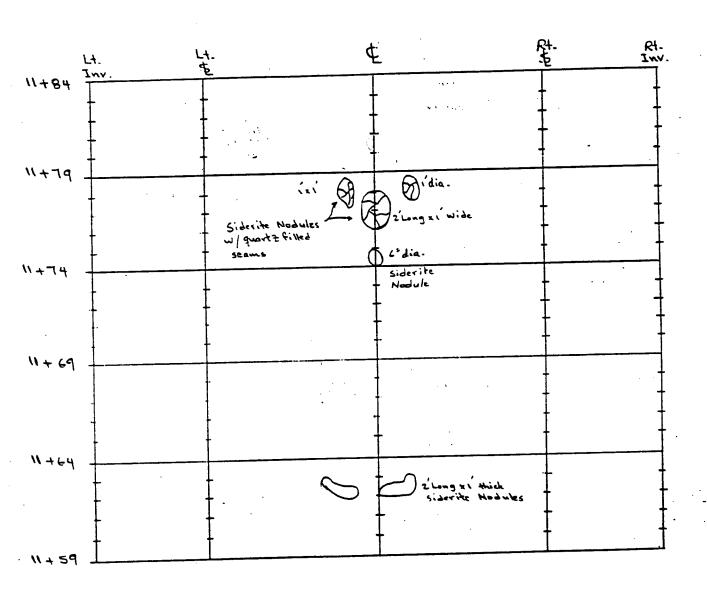
Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N. P. shale	Sheet 42	of 72



Project UTP	Computed	Date
	Checked	Date
	Sheet 43	01 72

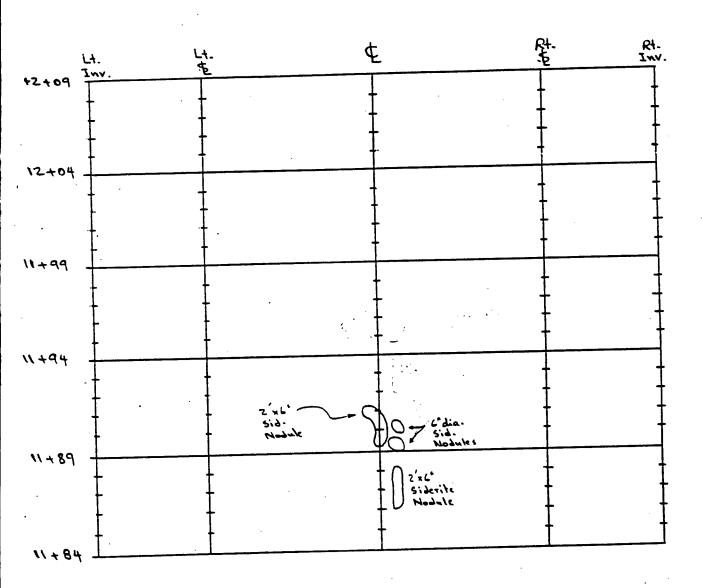


Project	UTP	Computed	Date
Subject		Checked	Date
Task	N. P. Shale	Sheet 44	01 72



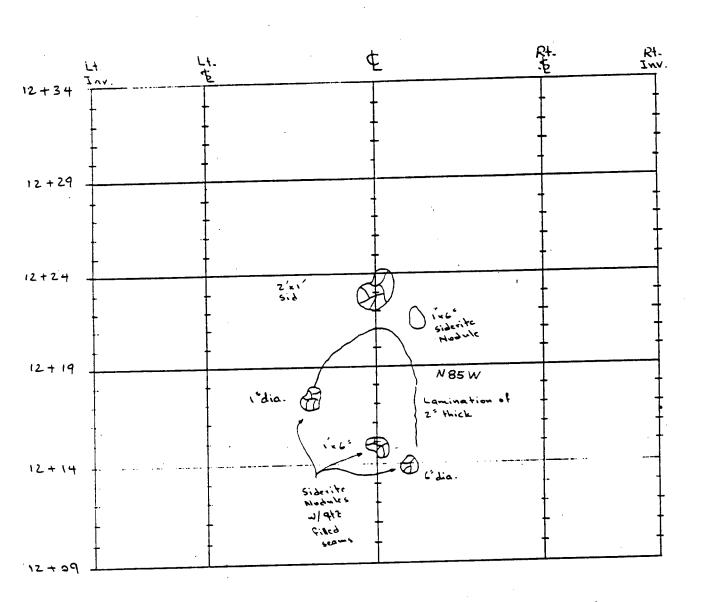
Massive Rock

Project	UTP	Computed	Date
Subject		Checked	Date
Tesk	Rock: N.P. shale	Sheet 45	of 72

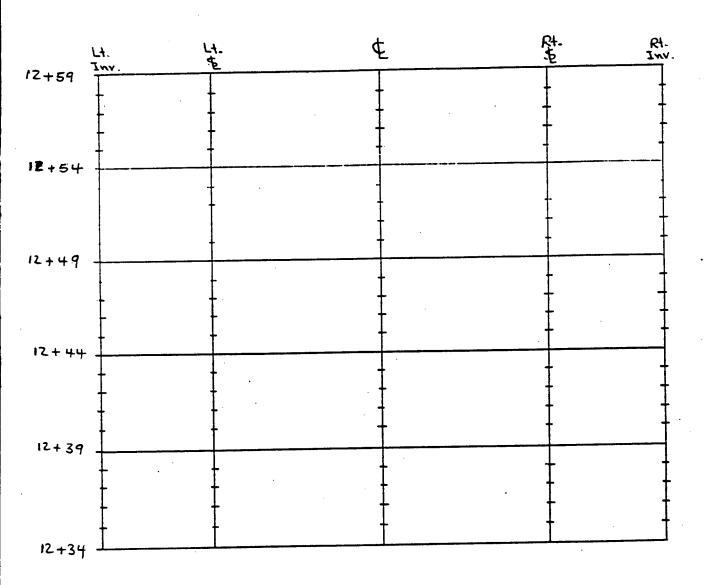


Massive Rock

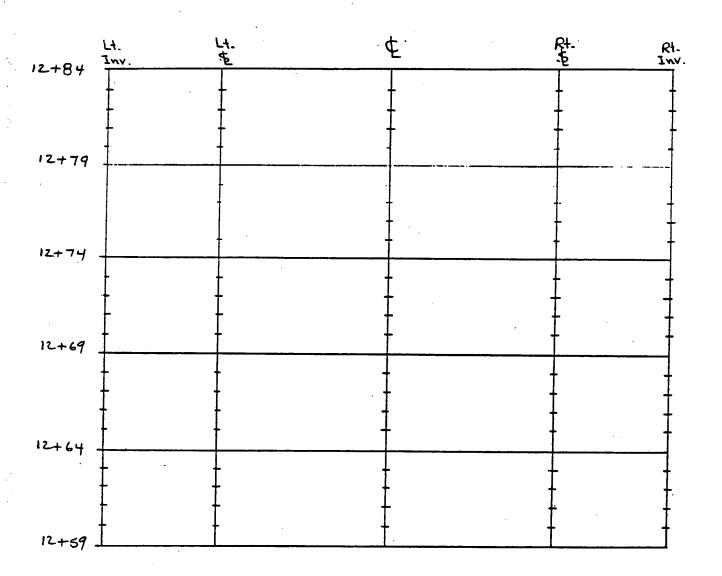
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: N.P. Shale	Sheet 44	01 72



Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 47	or 72

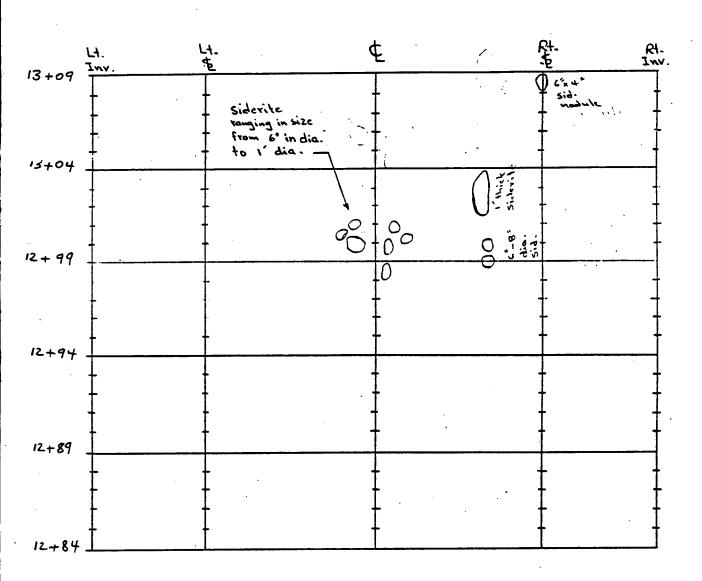


Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Prov. Shale	Sheet 48	01 72



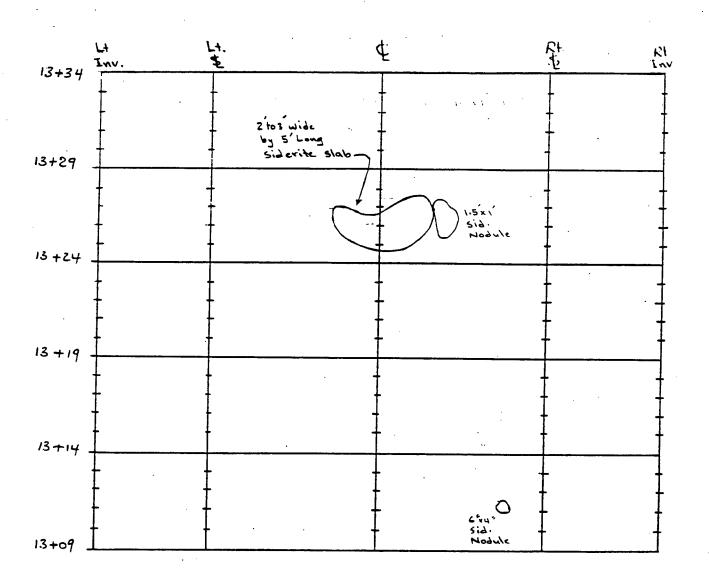
Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Took Rock: New Provid. Shale	Sheet 49	or 72

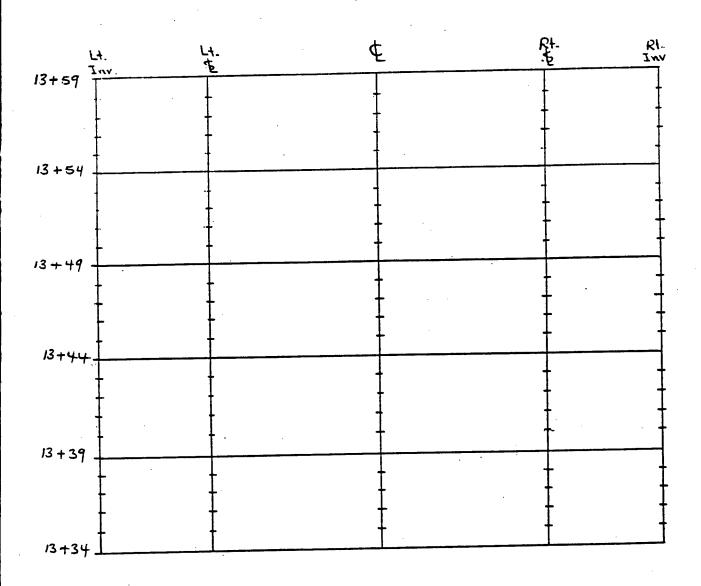


Massive Rock

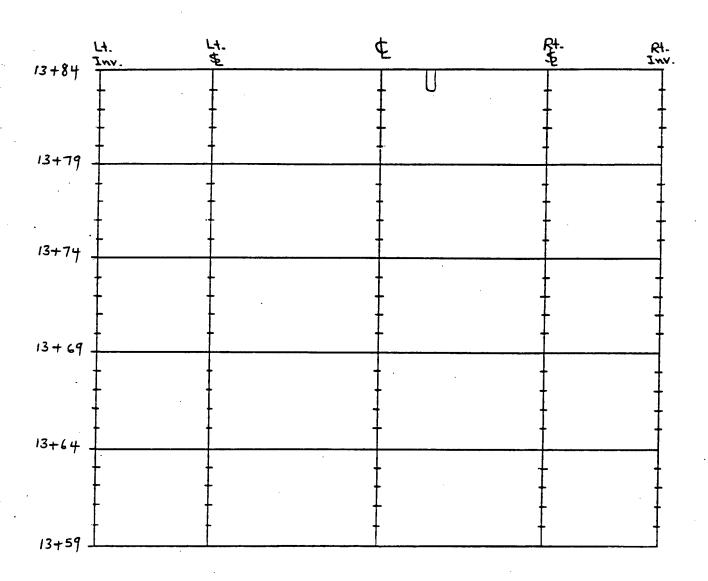
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 50	of 72



Project UTP	Computed	Date
	Checked	Date
	Sheet 5	01 72

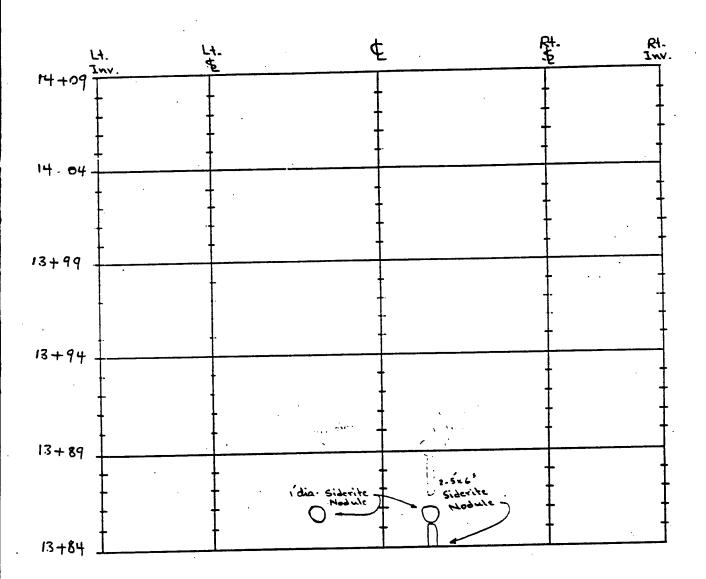


Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Prov. Shale	Sheet 52	of 72



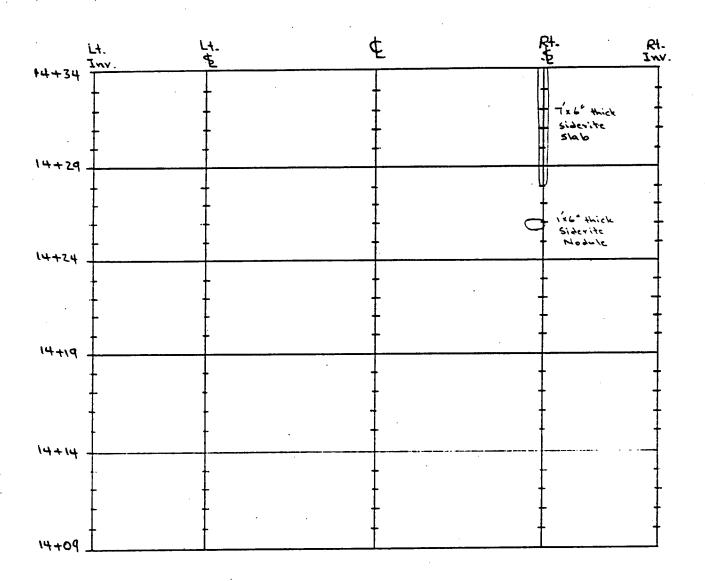
Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Tape Rock: New Providence shale	Sheet 53	or 72



Massive Rock

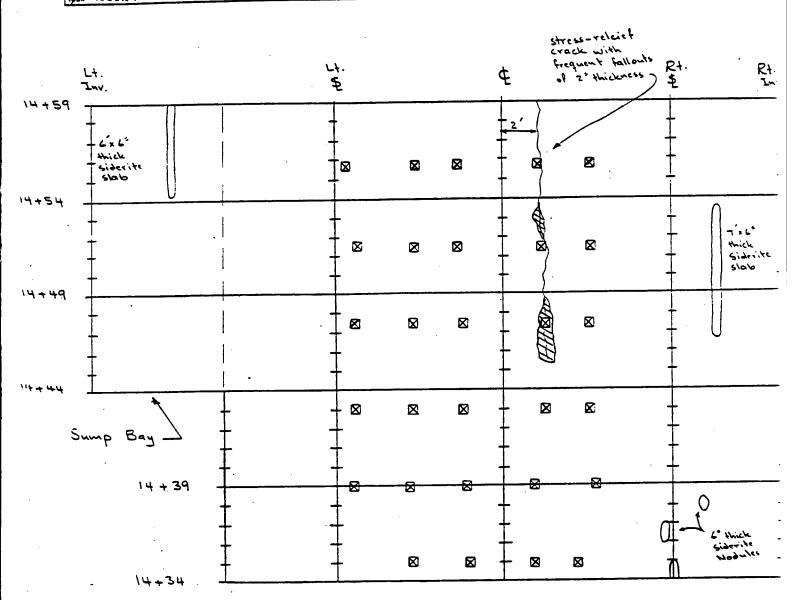
Project UTP	Computed	Date
Subject	Checked	Date
Tot Pack: New Providence Shale	Sheet 54	01 72



Massive Rock

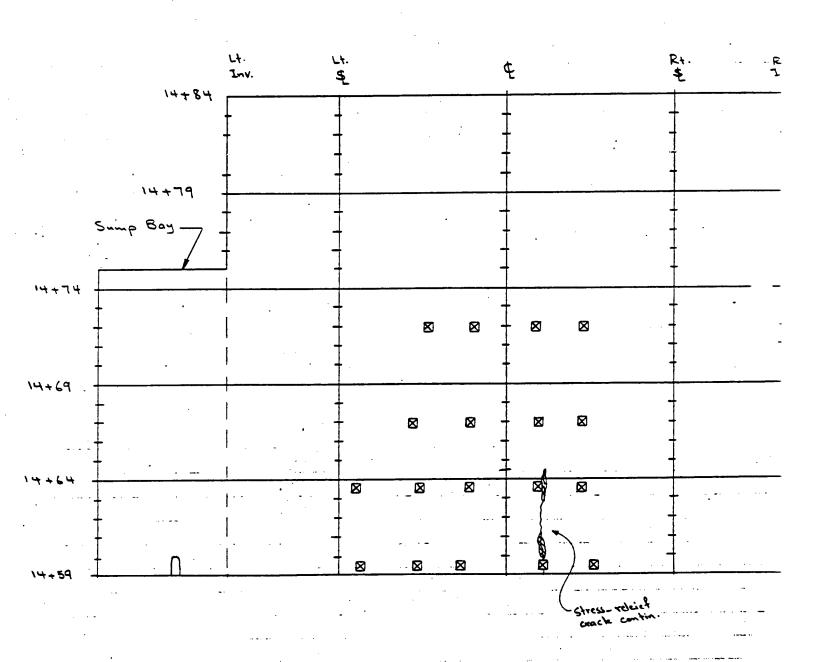
Job No.	 Įno į	

Project UTP	Computed	Date
Subject Sump Bay-Geologic Mapping	Checked	Date
	Sheet 55	or 72

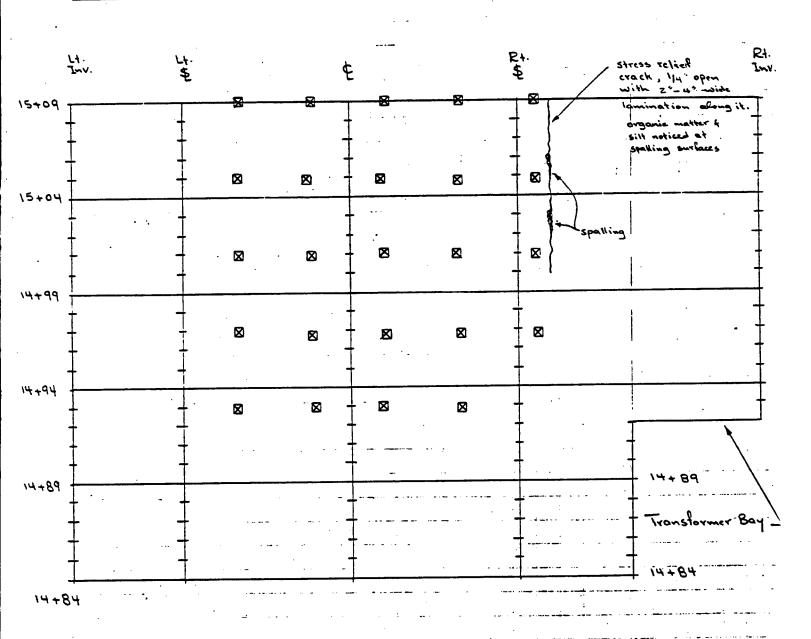


Massive Rock

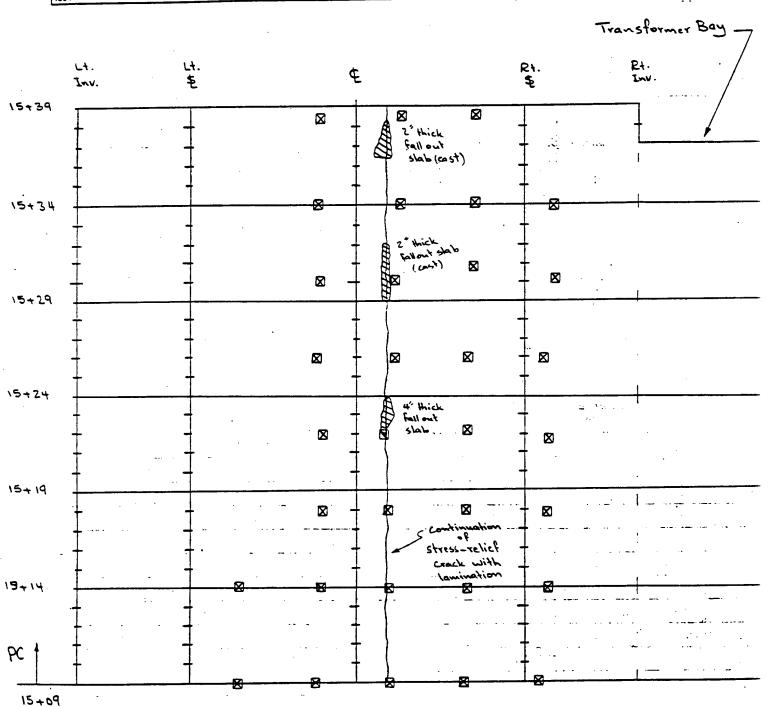
Project	UTP	Computed	Date
Subject		Checked	Date
Task		Sheet 56	or 72



Project UTP	Computed	Date
Subject Transformer Bay - Geologic Mapping	Checked	Date
Took Rock: New Providence Shale	Sheet 57	or 72

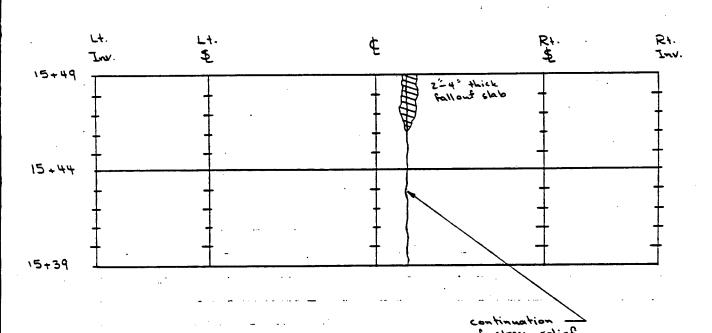


Project	UTP	Computed	Date
Subject		Checked	Date
Task		Sheet 58	or 72



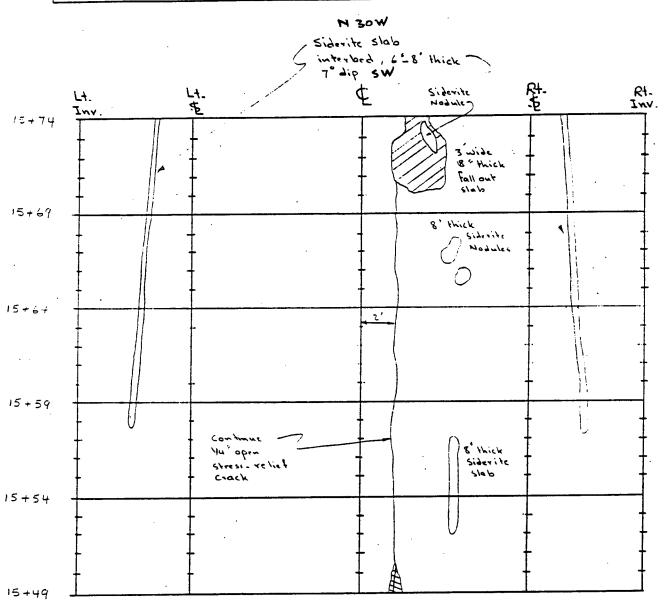
\* Tunnel Starts to curve to the left @ Sta. 15+09 (PC)
but curve is not shown here for ease.

ļ	Project UTP	Computed	Date
Ì	Subject	Checked	Date
1		Sheet 59	or 72

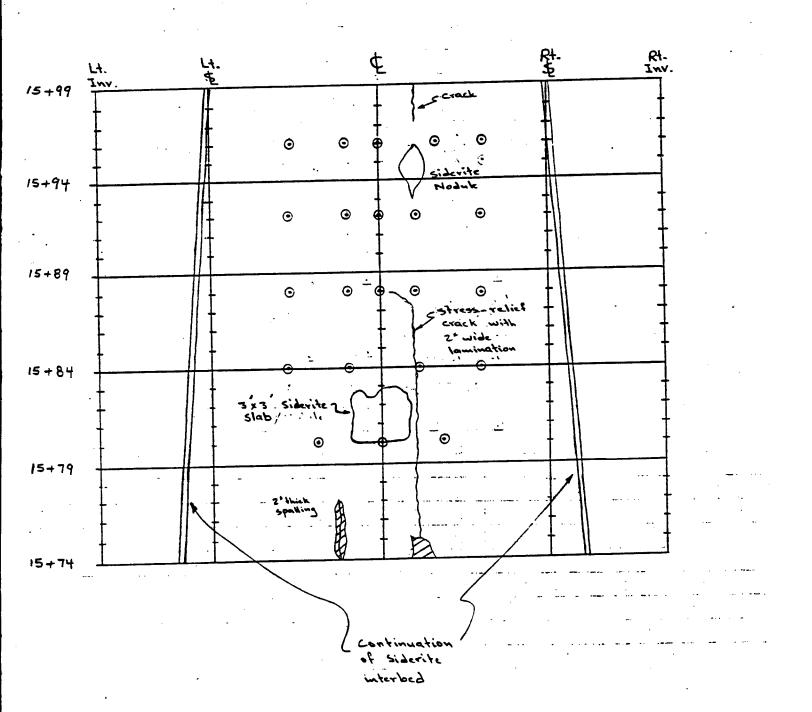


Job No.	INO.
300 144	

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 60	or 72



Project UT	·P	Computed	Date
Subject		Checked	Date
Task		Sheet 61	01 72



b No.		INU.

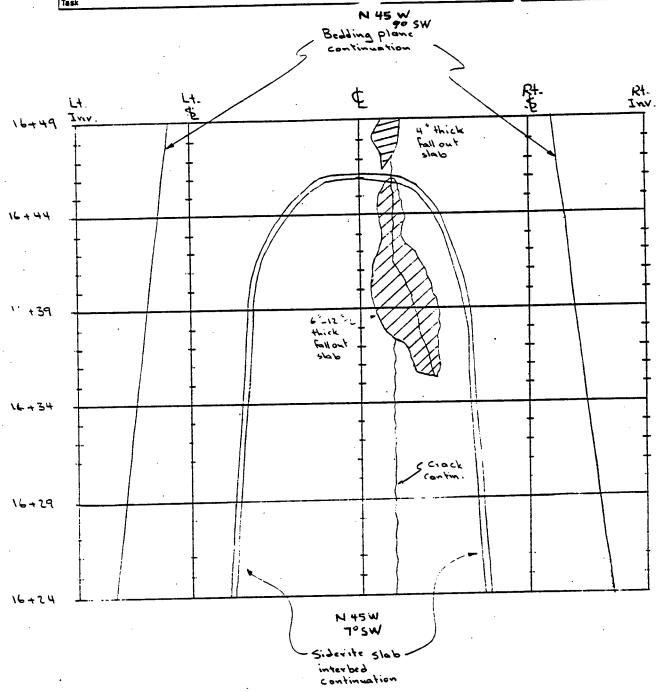
Project (	JTP			Computed		Date
Subject			····	Checked		Date
Task				Sheet 6	2	01 72
LA.	L4.	M US W  Q ° SW  Bedding plans in shale m/ lamination	* Hick	Rt.	,	21.
Inv.			-	.5	Ţ.	21. .nv.
		H 45 W 7° 5 W 512. 510 10	crack contw	····		+
	+					
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	<b>∦</b> ⊚	0	J. Fe			• (
		i	<u> </u>	- 11		of (al

6° thick fall out slab wo/ famination and stress-relief cracks

Stress-relief Crack, "14" open Continues

		1.	
Job No.		l No.	
JOD ING.	 		

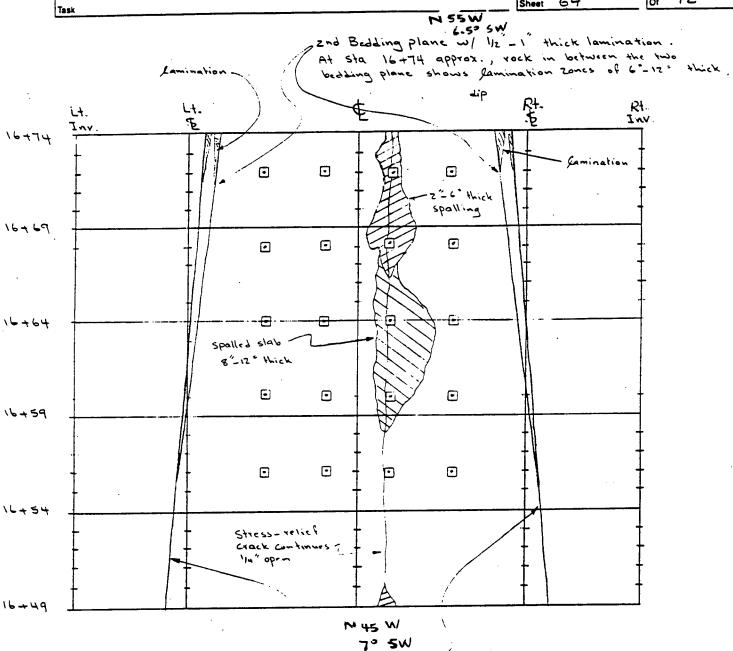
Project UTP		Compute	od	Date
Subject		Checked		Date
	, •	Sheet	63	01 72



Notice: Strees relief crack starts developing at 15-20 ft from heading as excavation progresses. Most falling rock start coming down in big chunks at about 20 ft from heading 4 only after 12 to 18 hours of exposure of newly excavared shale.

Job No.	No.

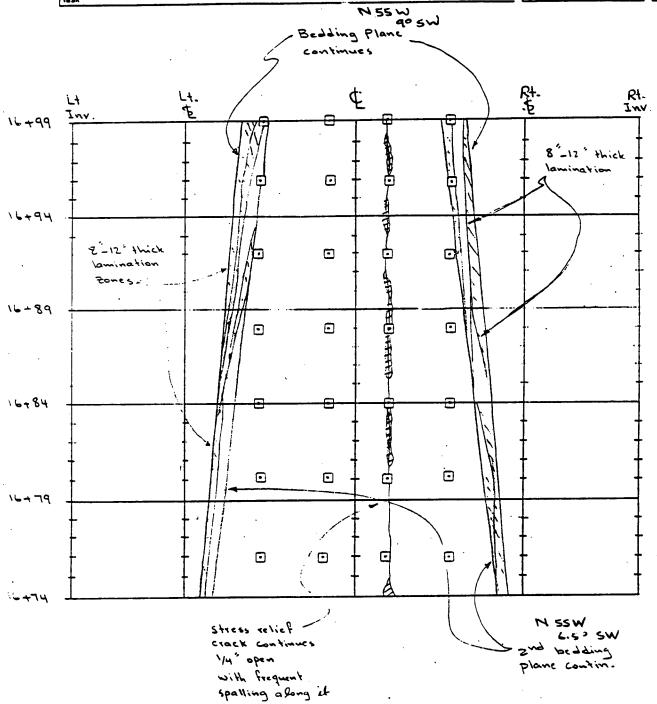
Project UTP	Computed	Date
Subject	Checked	Date
-	Sheet 64	or 72



Bedding Plane continues

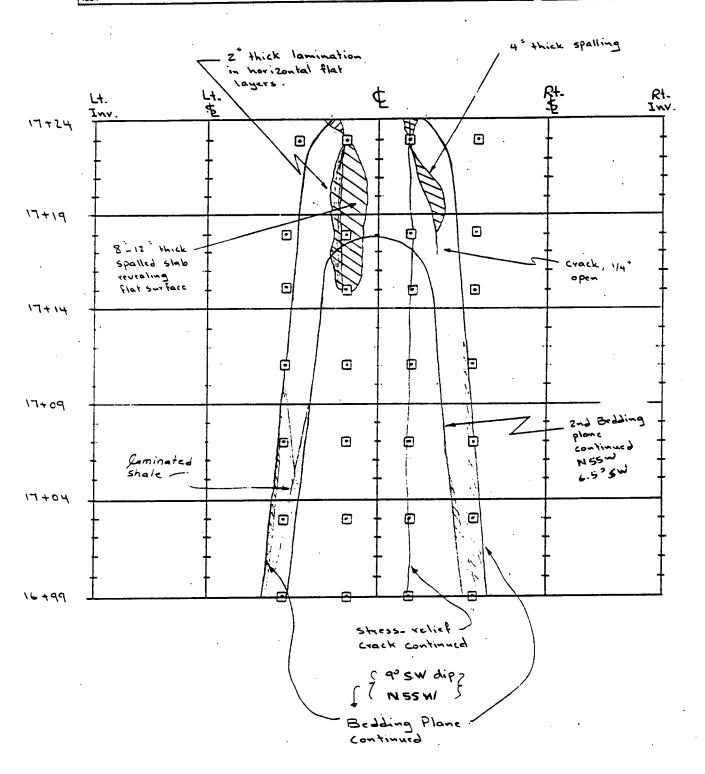
	i No	
lob Na.	- INC	

ļ	Project	UTP	Computed	Date
1	Subject		Checked	Date
1	Task		Sheet 65	01 72



		<b>1</b> .	
Job No.	-	INa	
JUU 140.		 	

Project UTP	Computed	Date
	Checked	Date
Test	Sheet 66	or 72

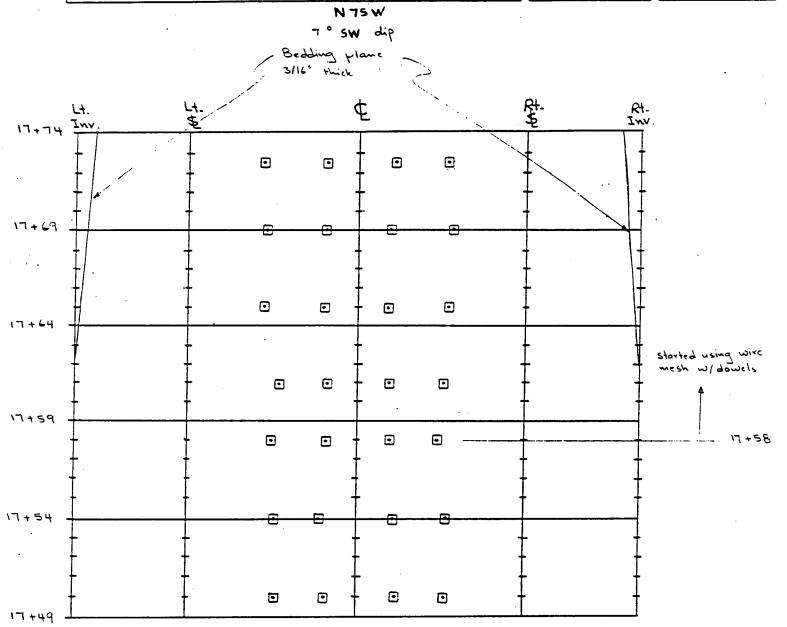


	Computed	Date
Project UTP	Checked	Date
Subject	(7	lor 72
Tack	Sheet 67	U 12

\* New Providence Shale started to change color from dark gray to greenish gray with hues of green & silt-brown banding ( layers of coloration) Rt. Inv. Lt. Lt. 17+49 17+46 ▣ Θ ⊡ 0 17+44 • **O** 0 0 .0 ⊡ 1-+39 stress-relief crock, 14° Spalling
slab, 22-3° open. thick ▣ ⊡ 17+34 ⊡ 4 - 6 thick Spalling slab 17+29 • 0 17+24 continued crack mith spaking Bedding Plane disappears into

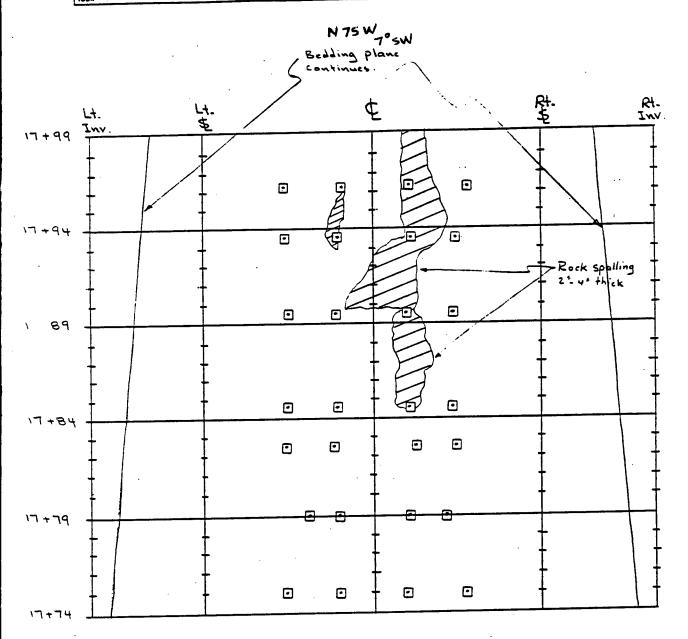
Job Na.	l Na

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 48	01 7Z

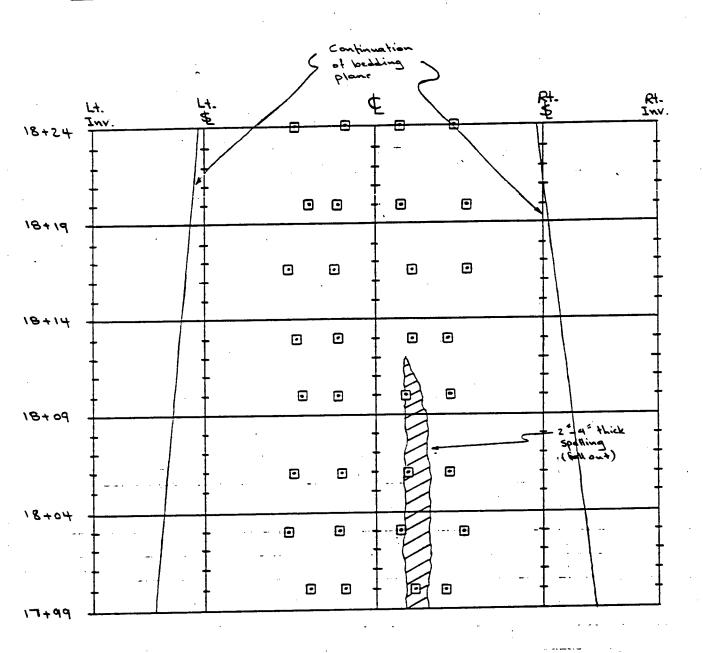


Job No.	No.

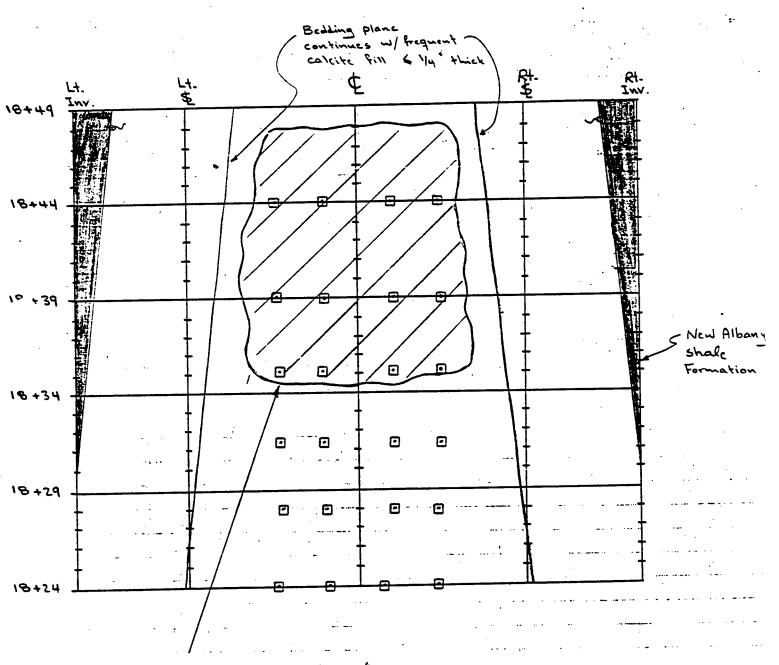
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 69	or 72



Project UTP	Computed	Date
	Checked	Date
	Sheet 70	or 72



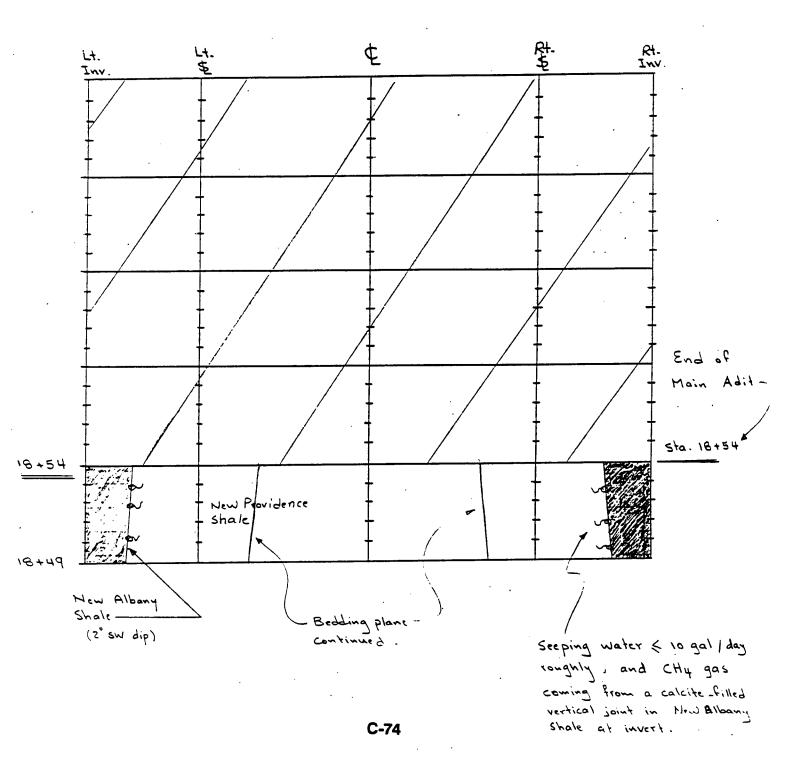
1170	Computed	Date
Project UTP	Checked	Date
Subject		or 72
Task	Silver II	



Spalling rock slab, 4-8° thick
fell due to long period of shale
exposure to air (>7 days) without
shotceting, Resulted in flat crown.

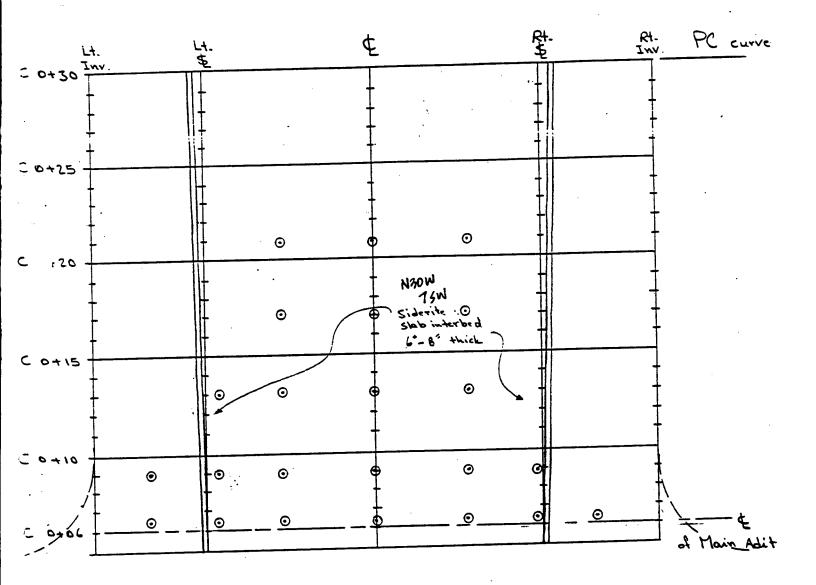
Job No.	_	No.
700 Left		170.

Project UTP	Computed	Date
Subject	Checked	Date
Tesk	Sheet 7Z	01 72



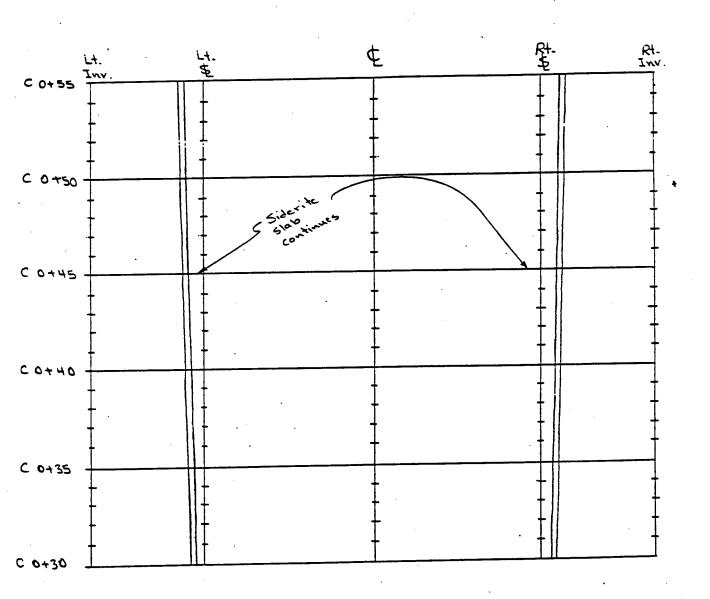
Project VTP	Computed	Date
Subject Geological Mapping of Colib. Adit	Checked	Date
	Sheet \	Of 21

Massive Rock



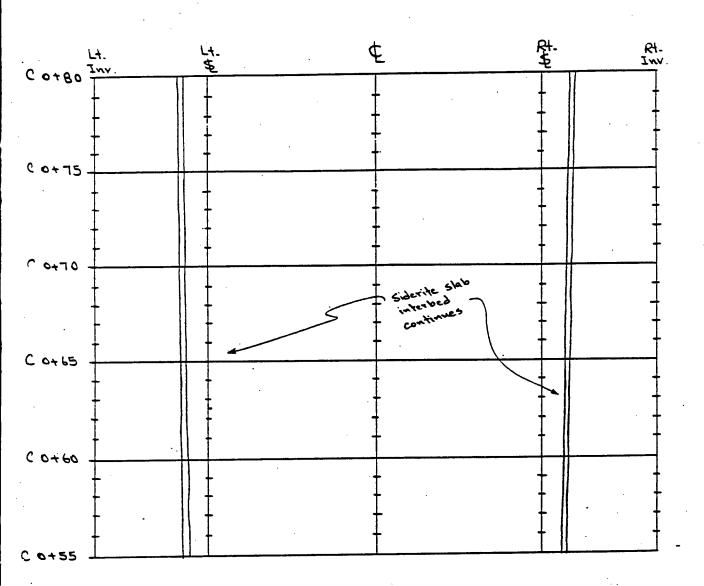
- \* Start station of Calibration Adit is C 0+00 @ center of Main Adit @ Sta. 16+00
- \* Cal. Adit has a curve; Curve #2 PC Sta. C 0+30'
  PT Sta. C 1+34.61

Project UTP	Computed	Date
Subject Geo. Mapping - Cal. Adit	Checked	Date
Task	Sheet Z	of 21



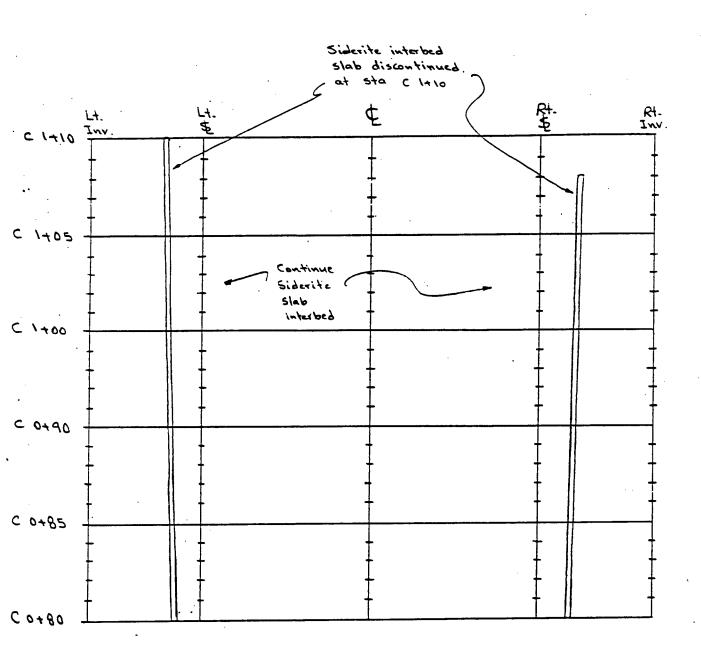
Massive Rock

Project UTP		Computed	Date
Subject Cal. Ad	+	Checked	Date
Task		Sheet 3	of Z1.



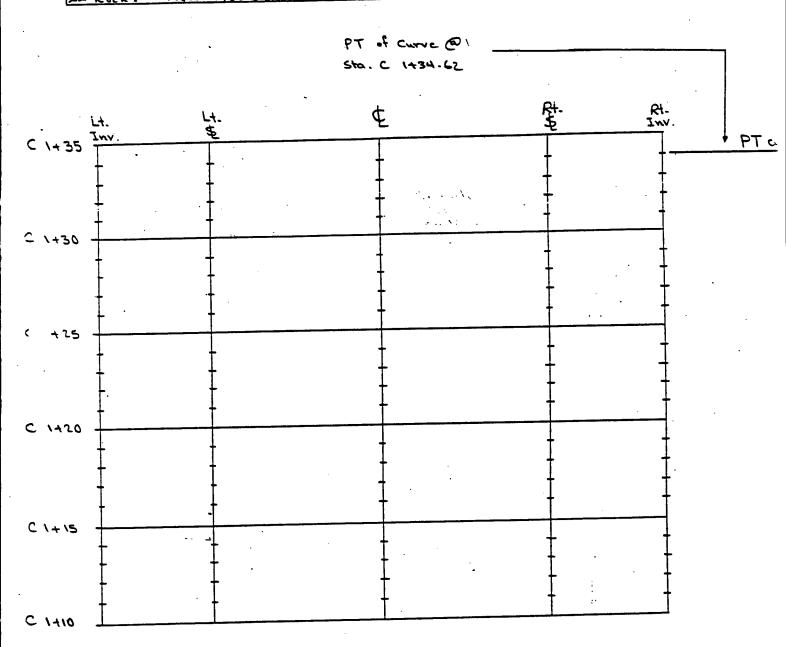
Massive Rock

Project	Project UTP				Computed Date		
Subject	cal.	4:6A				Checked	Date
Task		*				Sheet 4	01 21



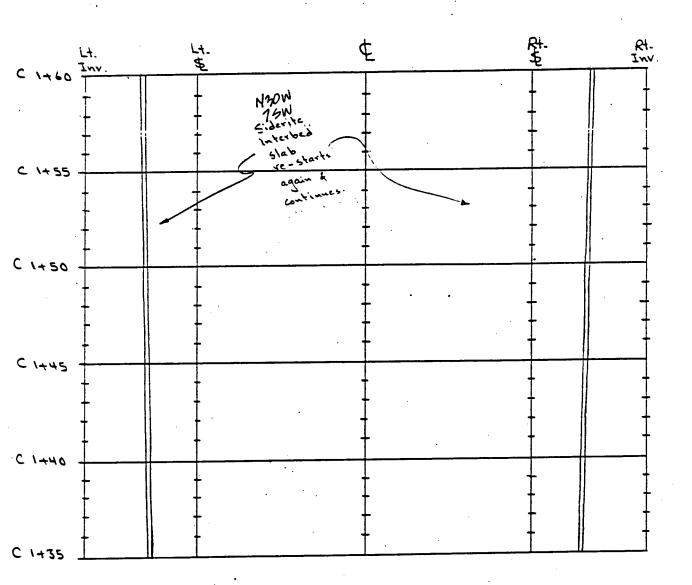
Massive Rock

1 1-5		Computed	Date
Project UTP	A \.\	Checked	Date
Subject Col.	ew Providence Shale	Sheet 5	or 21



Massive Rock

Project	UTP	Computed	Date	
Subject	Cal. A4;	Checked	Date	
Task		Sheet 6	or 21	



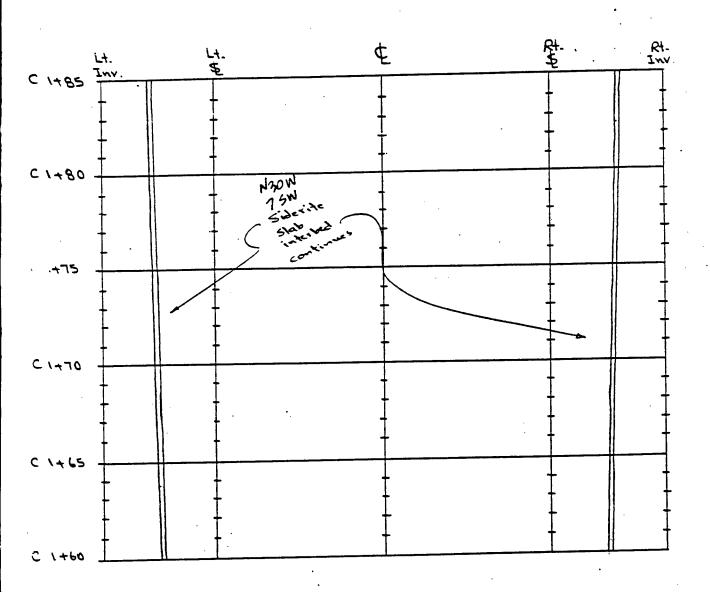
Massive Rock.

\* Sta. C 1+34.62 - Sta. C 5+24 (End of Cal. Adit)

Orientation of Cal. Adit = 335° (Running Parallel

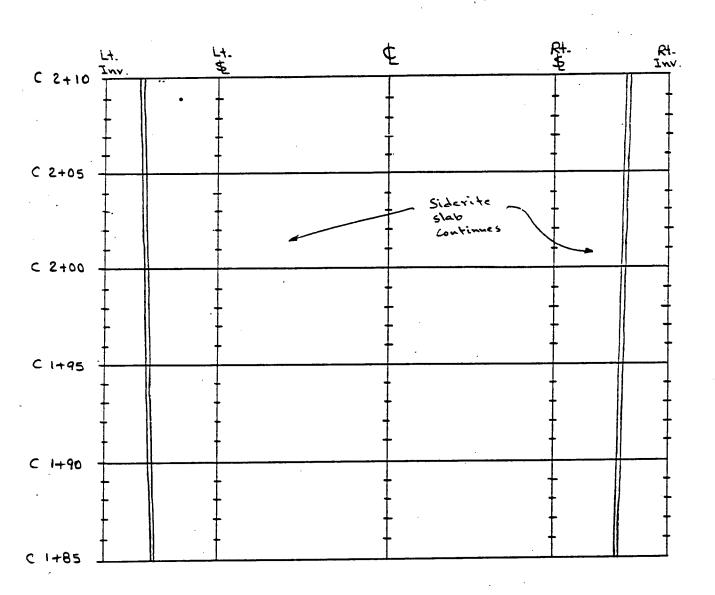
to Main Adit)

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Tesk		Sheet 7	of 21



Massive Rock

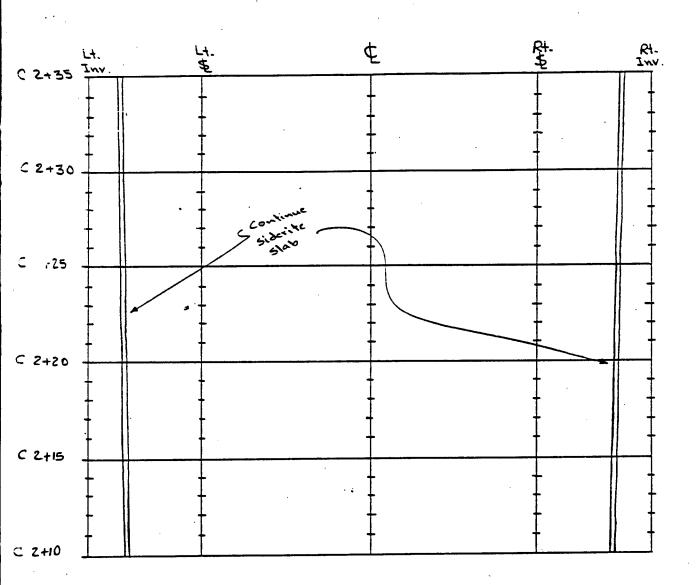
Project	UTP		<del></del>	Computed	Date
Subject	Cal.	4;6A		Checked	Date
Task				Sheet 8	0121



Massive Rock

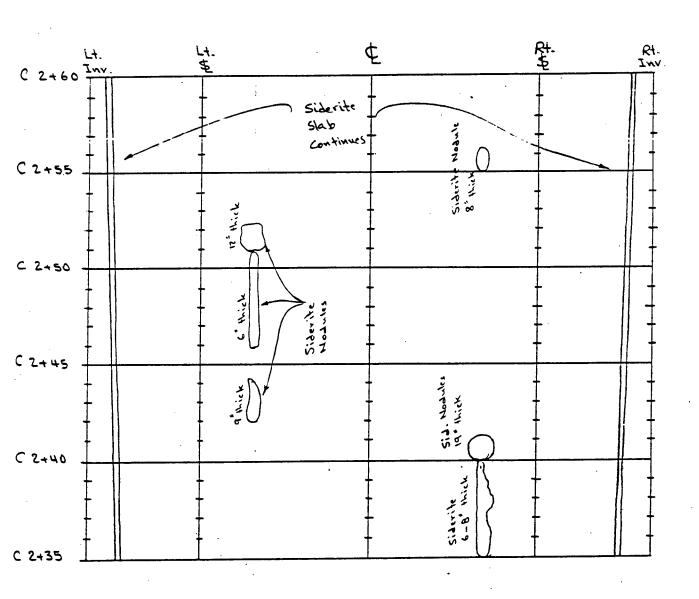
JOD NO.		 NO	

Project	UTP	Computed	Date
Subjec	cal. Adit	Checked	Date
Task		Sheet 9	or 2 \



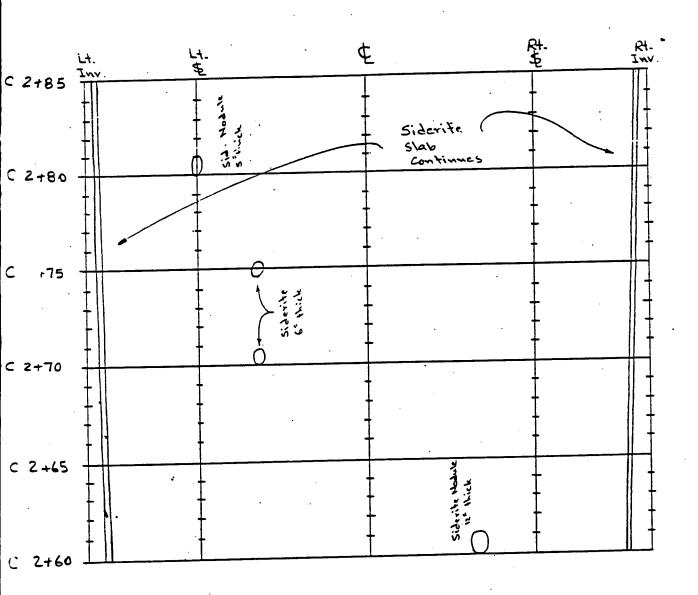
Massive Rock

Project	UTP		Computed	Date
Subject	cal.	Ad: 1	Checked	Date .
Task			Sheet \0	or .51



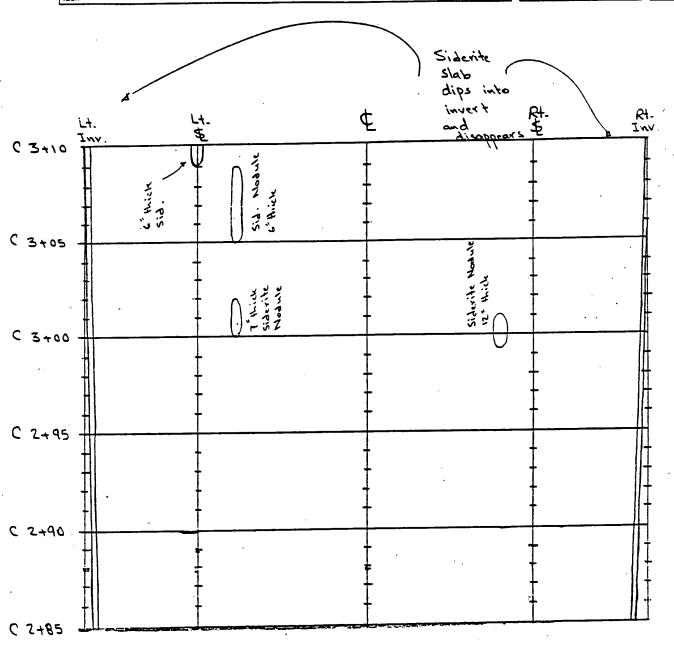
Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Tools	Sheet \\	or 21



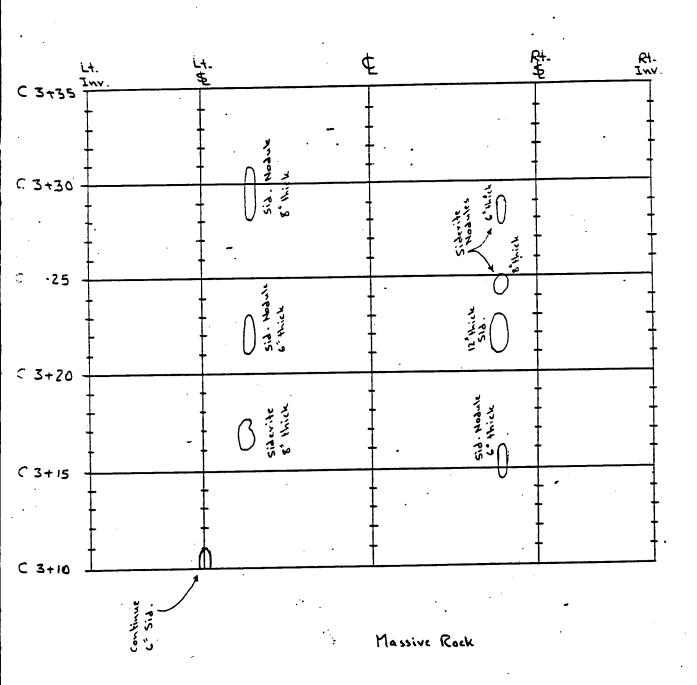
Massive Rock

Project UTP	Computed	Date
Subject Cal. A3:+	Checked	Date
Task	Sheet \2	01 21

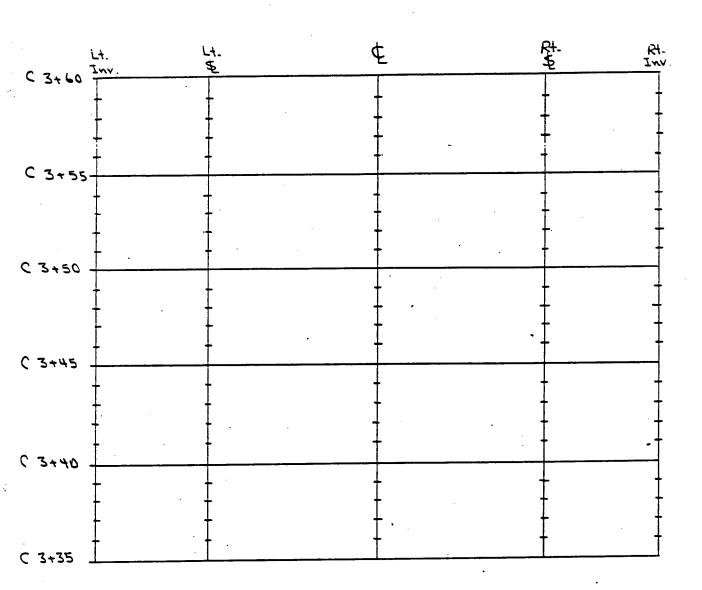


Massive Rock

	Project UTP	Computed	Date
	Subject	Checked	Date
ļ	Task	Sheet \3	or 21



Project UTP	Computed	Date
Subject Cal Adit	Checked	Date
Task	Sheet 14	or 21

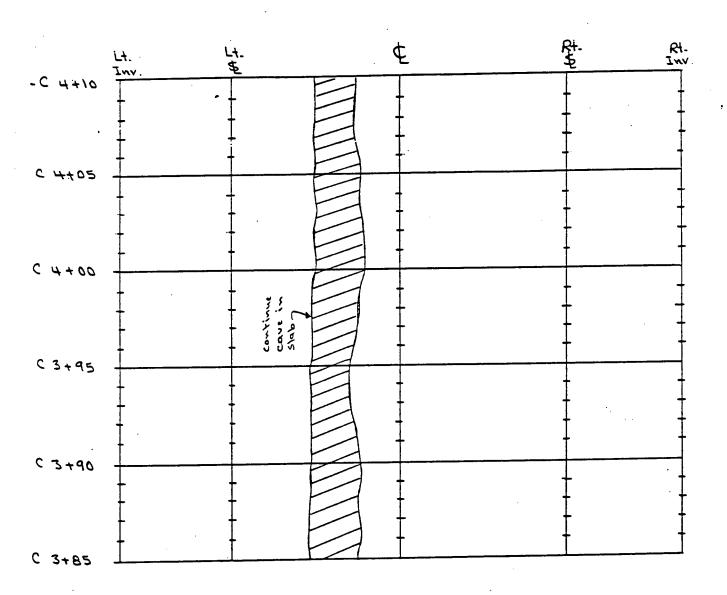


Massive Rock

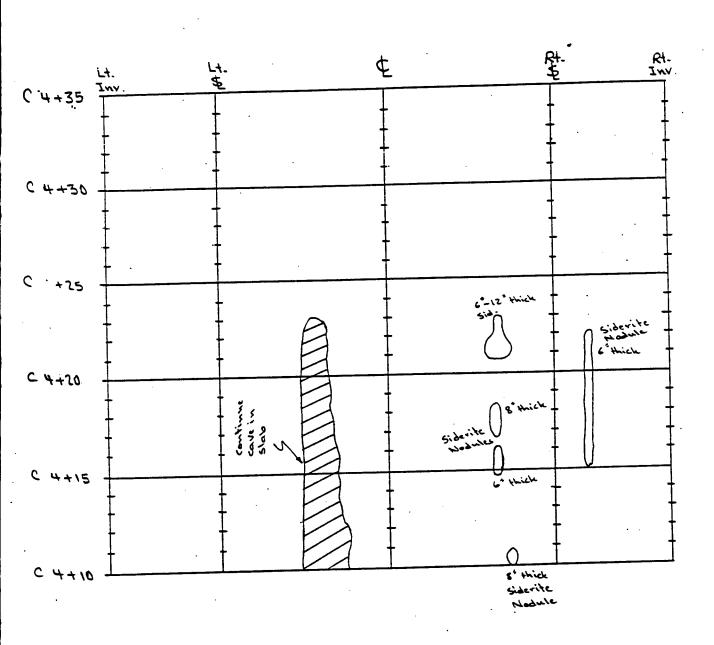
ļ	Project	UTP					Computed	Date	
	Subjec		4:+				Checked	Date	
,	Task				<u>.</u>	·	Sheet \5	01 21	
		t.	-t.	Cave in that fell down due to 10	A air exposure	Detached rock has a pyramid- shaped cross section with  6-18* height	My discontin-	RI- Inv.	
3+8	5 T			1//		<u></u> 0:			
	†	(In the state of t	C. Wick Siderik		† †		Ţ 	÷ +	
3+8	۰ +								
7	5	Sidevile			+		<u> </u>		
3+7	0	- - -	<del> </del>		+ (	13.7.4.3 13.7.4.3 13.7.4.3	+	† 	
: 3+6					+		+	<u>+</u> .	
. JT <b>v</b>	7		+		+	· •	+	+	
	1	_ · ·	<b>†</b> :		Ţ		‡	<u> </u>	
<b>.</b>	1		T		Ŧ.		+		

\* This cave-in occured @ one time. Shotcrete liner was @ Sto. (3+75 and Face @ Sta. (4+27 when cave-in occured.

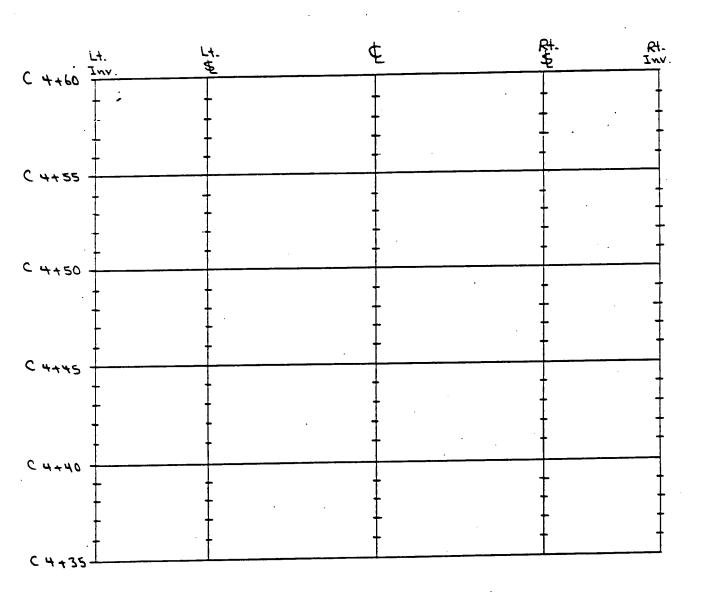
Project UTP	Computed	Date
Subject Cal Adit Geo. Mapping	Checked	Date
Task	Sheet \6	or 21



Project UTP	Computed	Date
	Checked	Date
	Sheet \7	0 21

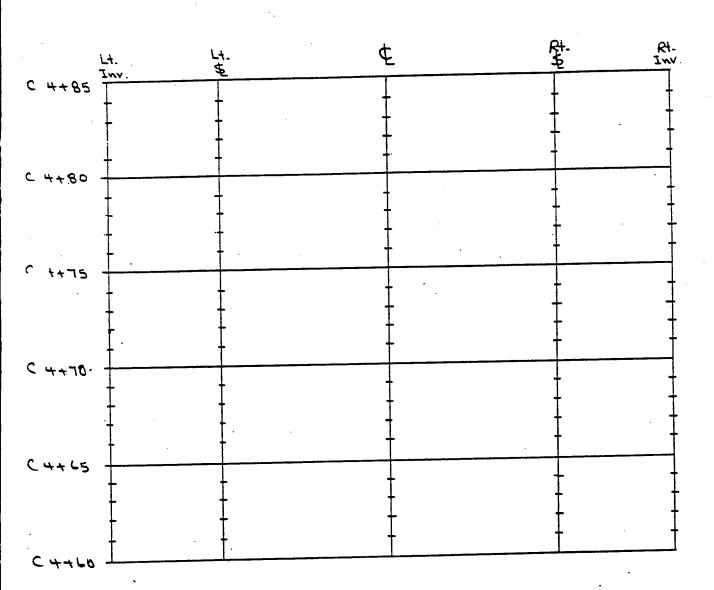


Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 18	Of 21



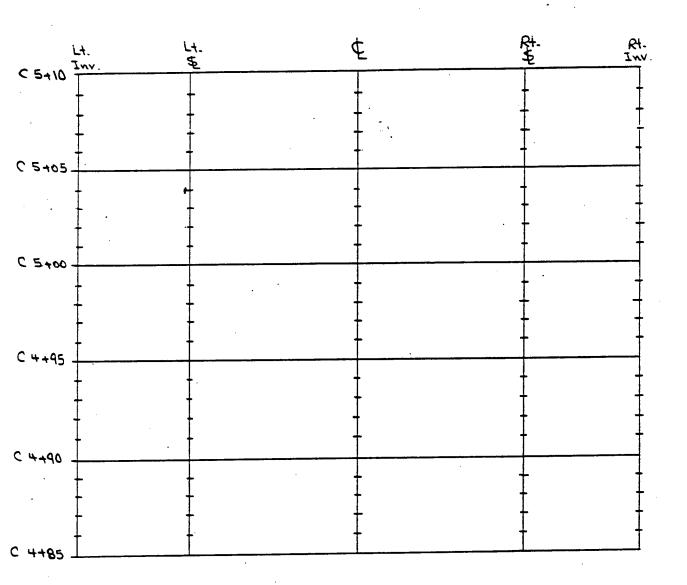
Massive Rock

Project UTP	Computed	Date
L ANN	Checked	Date
Subject Cal. Addit	Sheet \Q	or Z\



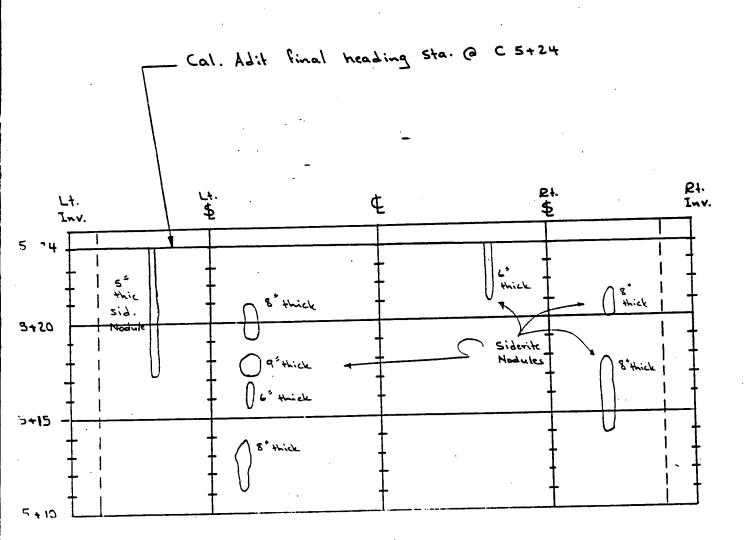
Massive Rock

Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet ZO	or 21



Massive Rock

Project UTP	Computed	Date
Subject Cal. Adit - Geological Mapping	Checked	Date
Took Rock: New Providence Shale	Sheet 21	01 21



\* Tunnel is wider by 3 from sta. (5+10 to C5+24

Appendix D
Photographs

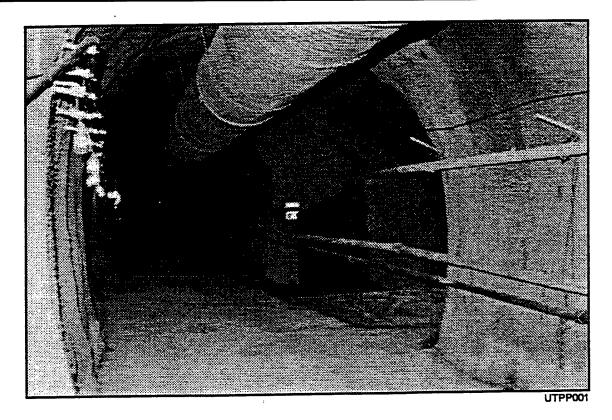


Figure D-1. Sump Bay.

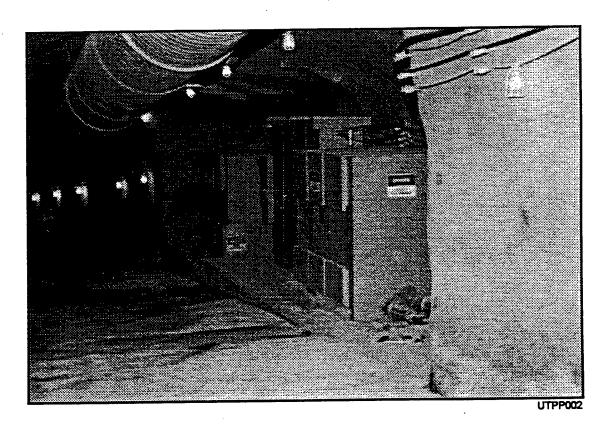


Figure D-2. Transformer bay (looking in).

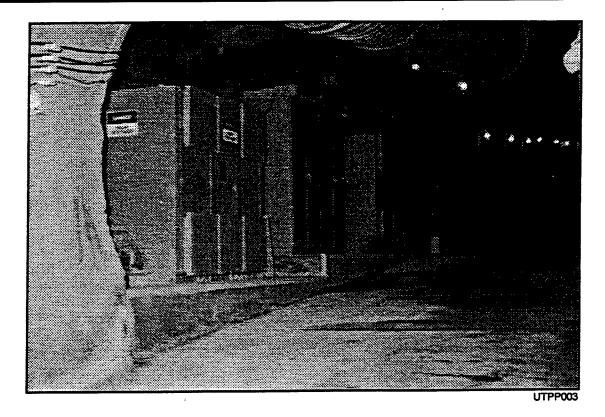


Figure D-3. Transformer Bay.

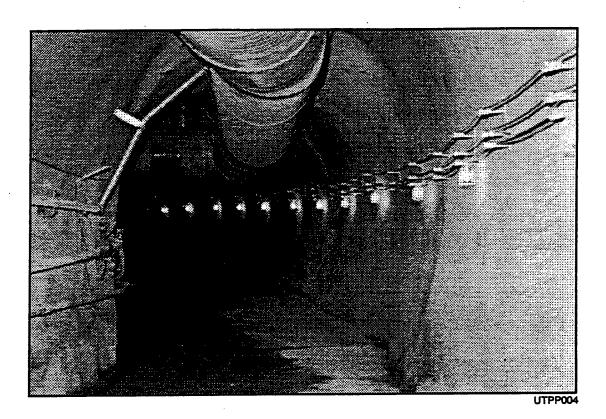


Figure D-4. Intersection (Cal. Adit to Left).

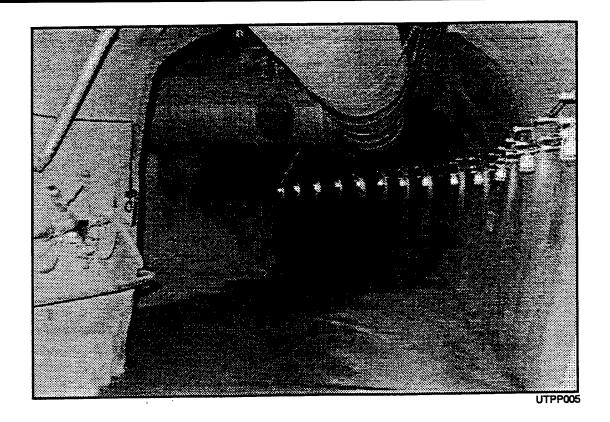


Figure D-5 Intersection ( Cal. Adit to Left )

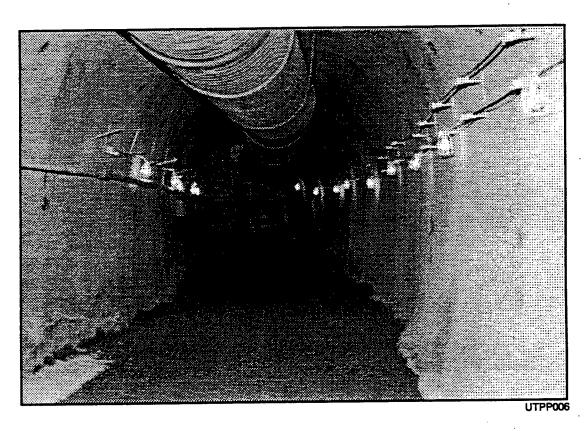


Figure D-6 Test Adit Looking Towards Plug

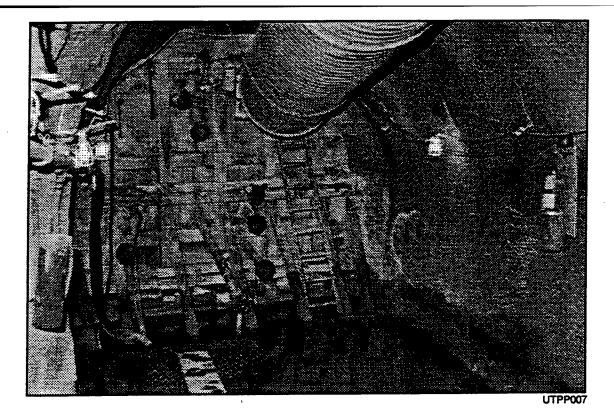


Figure D-7 Plug's Upper Face

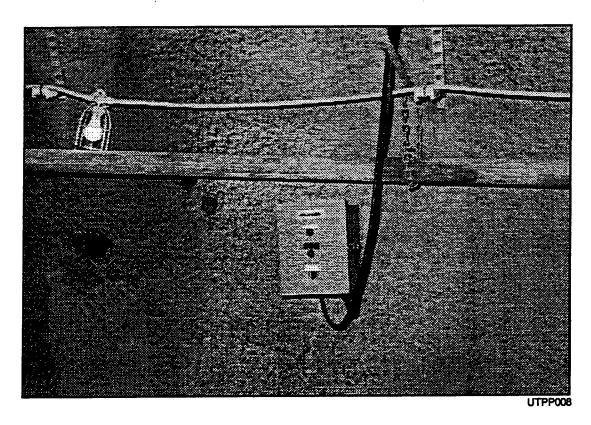


Figure D-8 Typical Electric Switch for Water Pump at Bulkhead

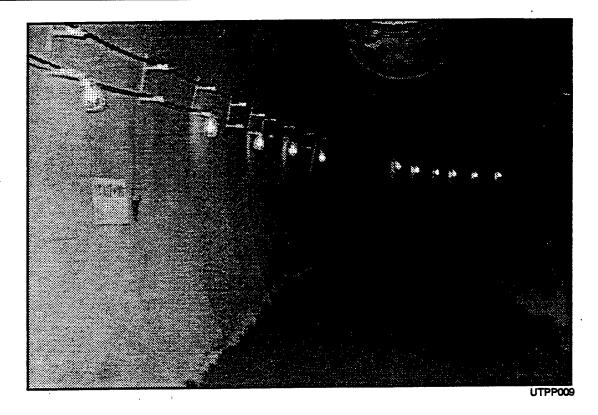


Figure D-9 Test Adit at Sta. 17+00

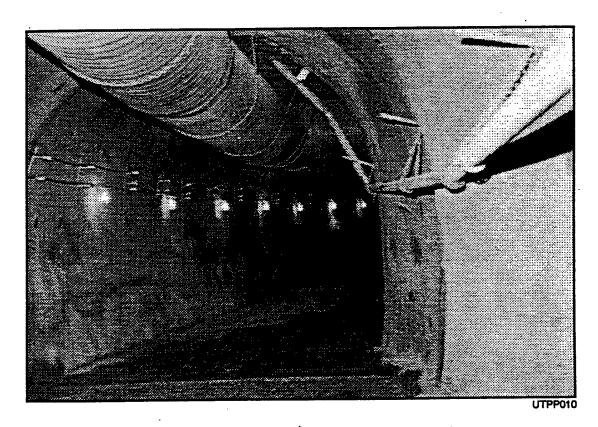


Figure D-10 Test Adit Intersection with Cal. Adit

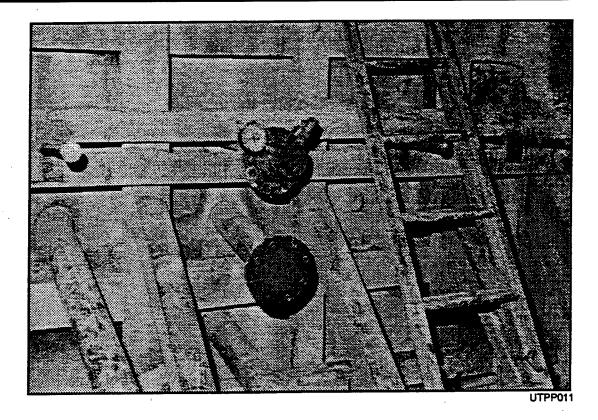


Figure D-11 Plug ( Upper Bulkhead with Fill-Bleed Lines Shown )

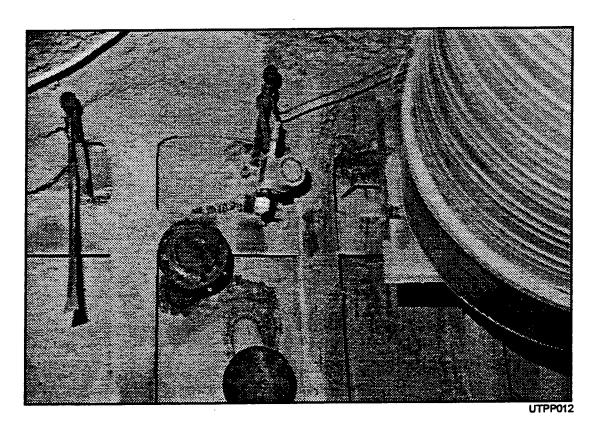


Figure D-12 Gas Monitor at Plug

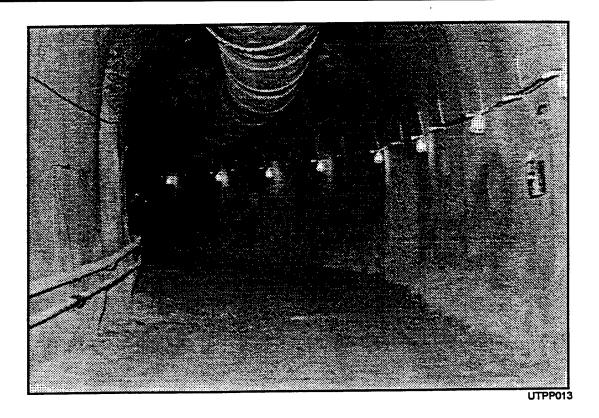


Figure D-13 Cal. Adit ( Looking from Intersection )

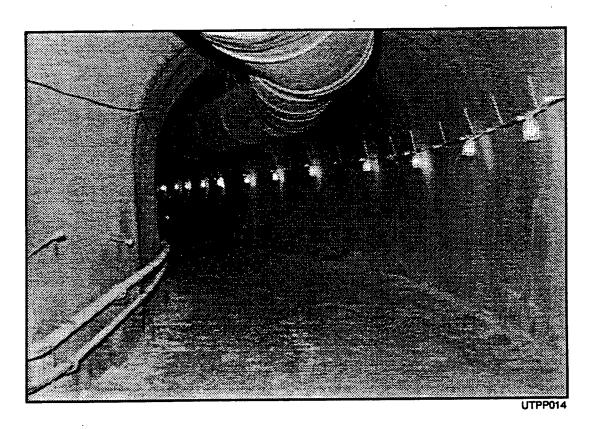


Figure D-14 Cal. Adit

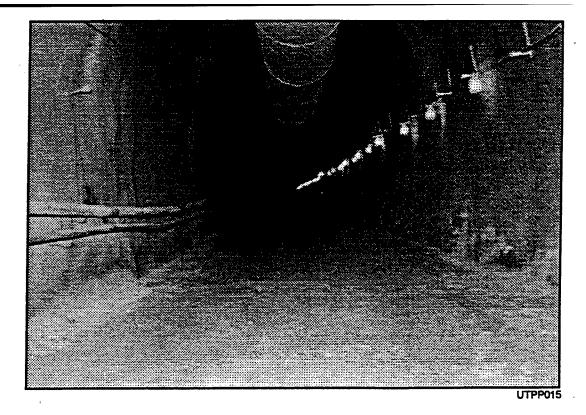


Figure D-15 Cal. Adit (Looking towards its Terminal Station)

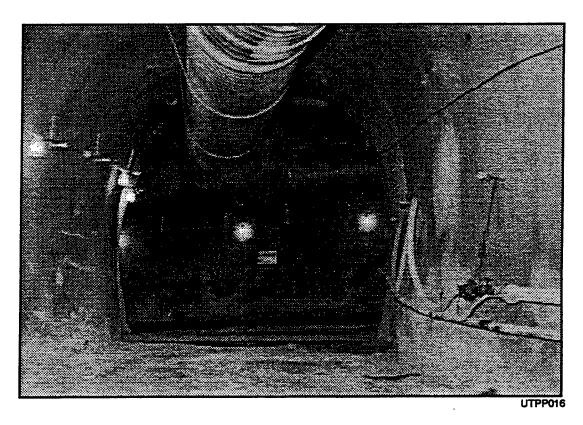


Figure D-16 Intersection ( Looking from Cal. Adit )

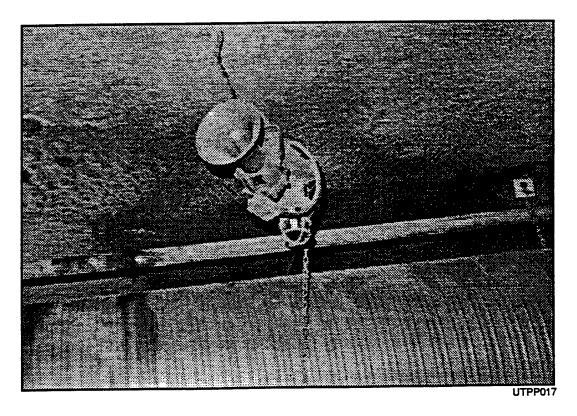


Figure D-17 Gas Warning/Monitor Siren and Light

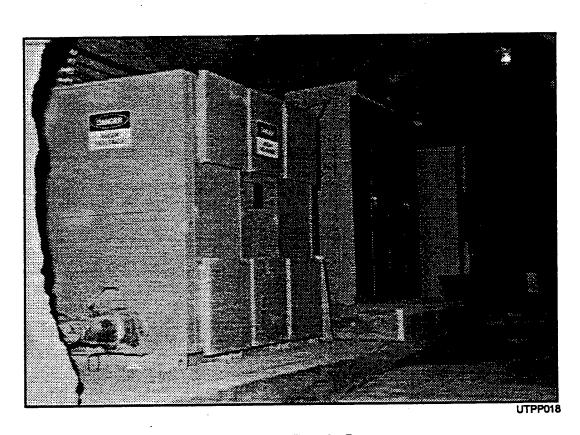


Figure D-18 Transfer Bay

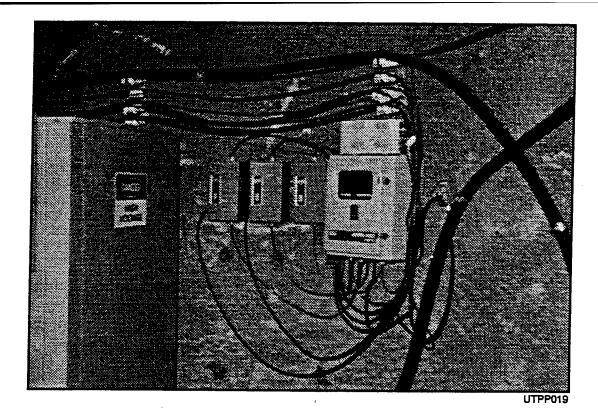


Figure D-19 Electric Controls and Gas Monitor Box

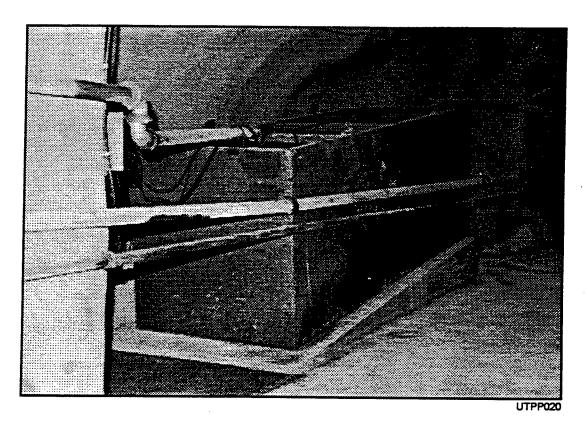


Figure D-20 Sump Tank at Sump Bay

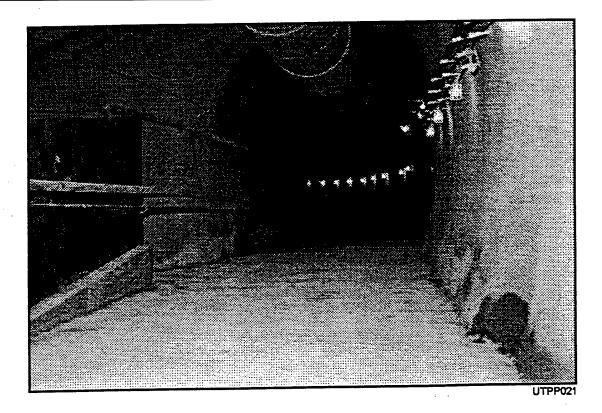


Figure D-21 Sump Bay

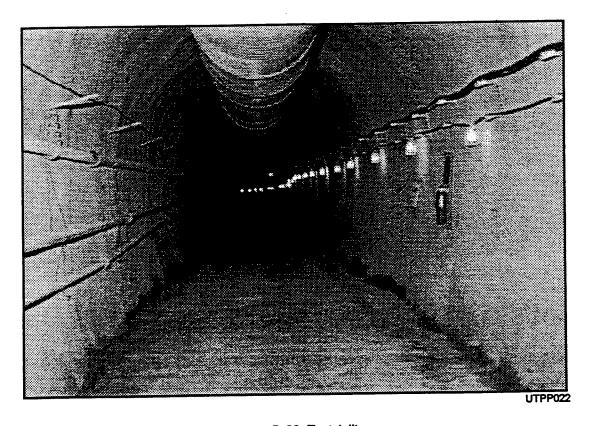


Figure D-22 Test Adit

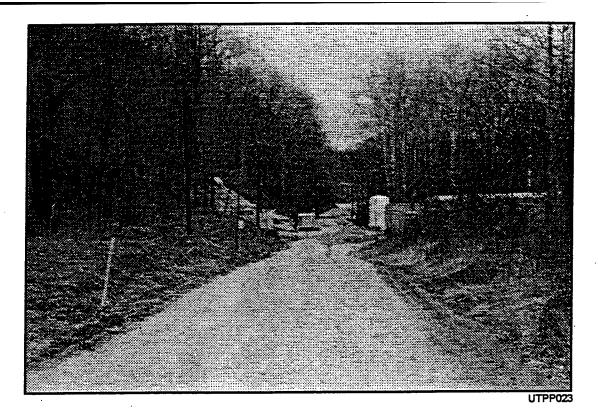


Figure D-23 Access Road to Rodgers Hollow ( Portal on Left )

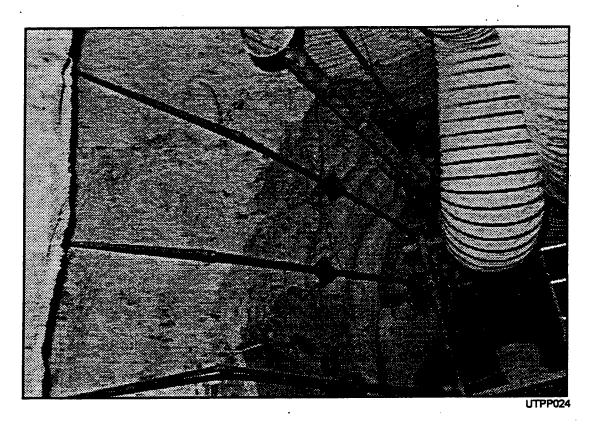


Figure D-24 Plug During Construction. Shown are Pressure Grout Pipes with Gas Checks ( Plates ) and 4" Dia. Bleed Lines

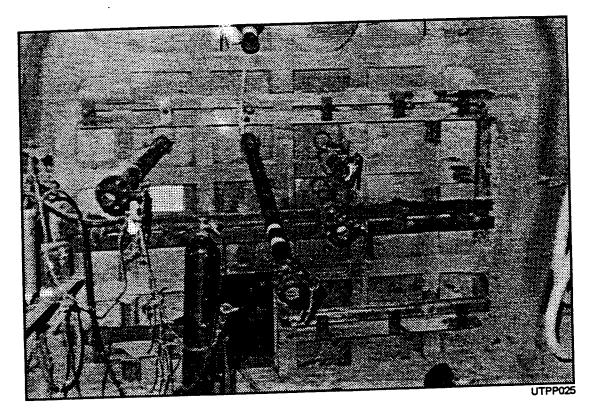


Figure D-25 Front (Upper) Bulkhead with Fill and Bleed Line Penetrations

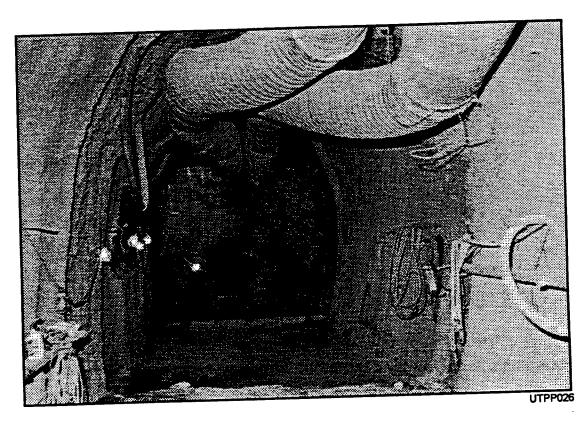


Figure D-26 Finished Rear ( Lower ) Bulkhead from Inside Plug

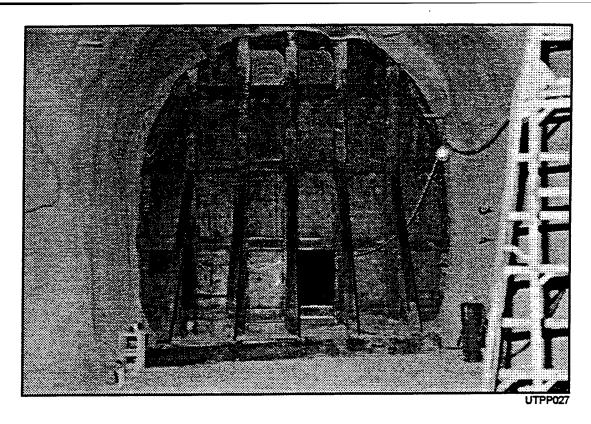


Figure D-27 Back of Lower Bulkhead Prior to completion. Shown are Supports and Access Opening

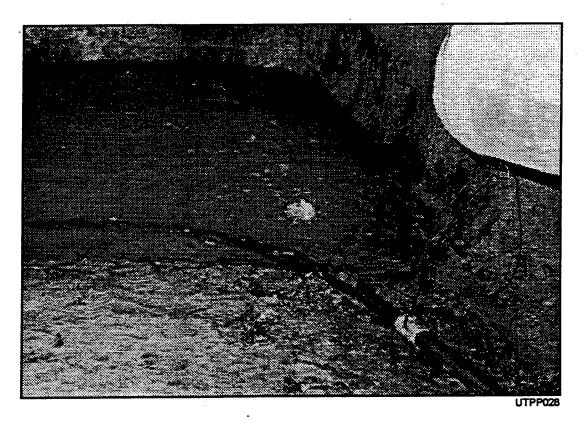


Figure D-28 Gas (Methane) Seepage at Sta. 18+50

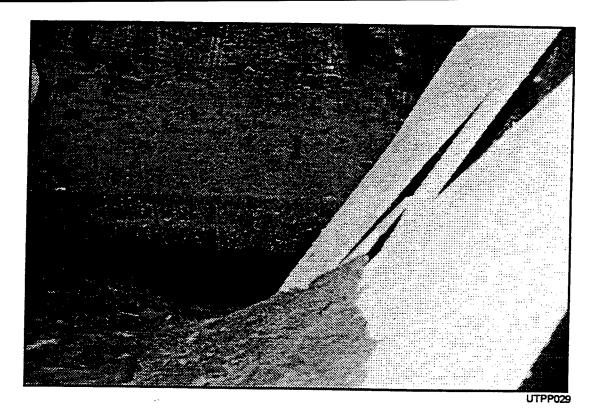


Figure D-29 Interface Bewteen New Providence Shale (Top) and New Albany Shale (Bottom) at Sta. 18+54

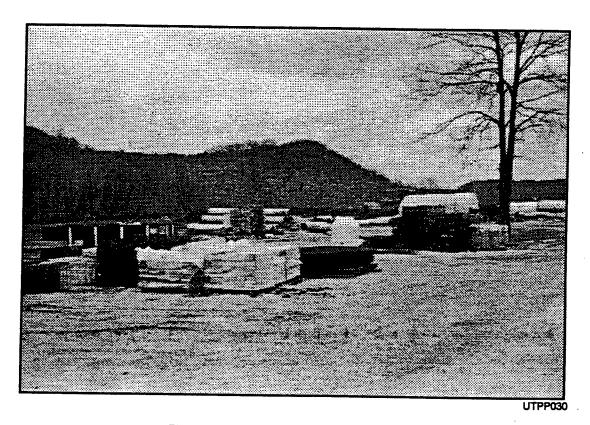


Figure D-30 Yard (Storage) Area on Site

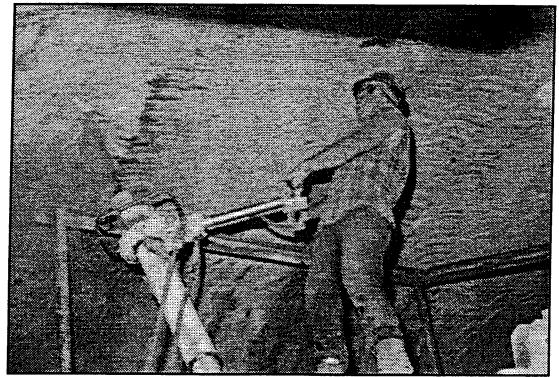


Figure D-31 Rock Bolt Installation

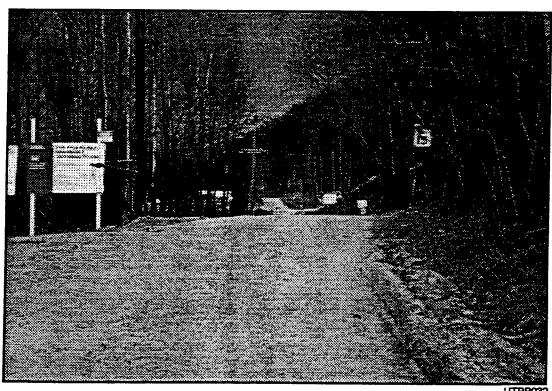


Figure D-32 Access Road to Site ( Portal on Right )

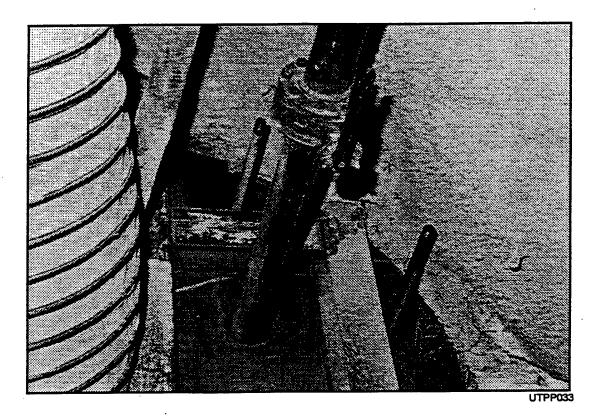


Figure D-33 Gas Bleed Line with Valve Penetrating Upper ( Front ) Bulkhead

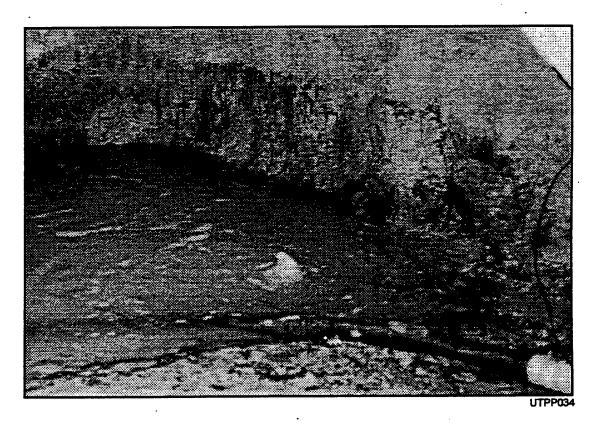


Figure D-34 Gas Seepage at Sta. 18+50



Figure D-35 Piezometer Monitoring Assembly P-1

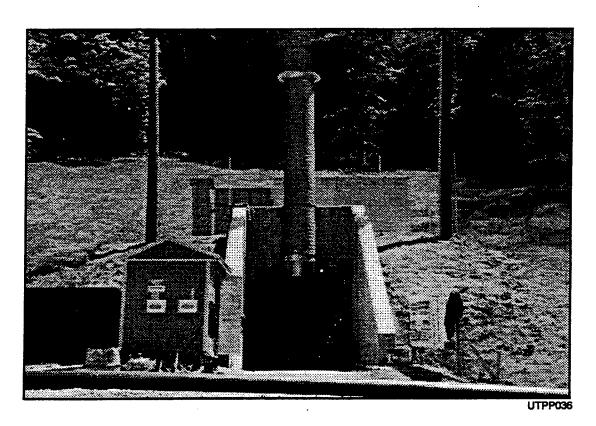


Figure D-36 Portal Showing Final Vent Exhaust and Electrical Substation on Top ( Stack Removed Recently for Safety Reasons )

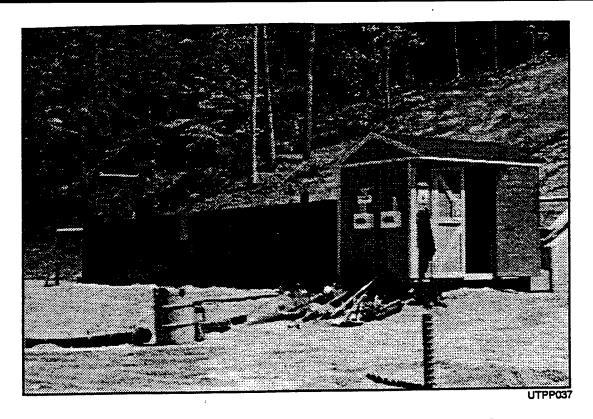
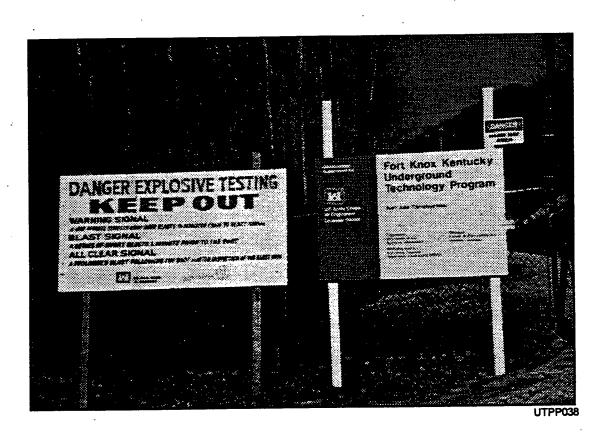


Figure D-37 Sump Tanks Outside Tunnel Delivering Water Pumped Out of Tunnel to Dewatering Line Going to Salt River



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